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The " Exposition Flyer," which is to make the run between New York and Chicago in 20 hours, started from the Grand Central Station, New York, at 3 p. m., May 28. As noted in our issue of May 25, the train runs over the New York Central R. R. and Lake Shore & Michigan Southern Ry., the length of its run being 980 miles. The train consisted of an eight-wheel engine, three sleeping cars and a buffet smoking car, a dining car being attached at Albany. The cars were specially built for this train by the Wagner Palace Car Co. The trains reached Chicago and New York on Monday, a little ahead of time.

The New York Dock Board has adopted plans for the expenditure of $10,000,000 on new piers and docks. These piers, it is said, will extend from Charles St. to 23d St., and from West 72d to West 100th St. No detailed plans are yet given out by the Board.

A new dam is proposed across the Mississippi River, at Minneapolis, which will cost about $1,000,000 and give a fall of 20 ft. the entire width of the river. The builders are to be the English milling syndicate which absorbed the Washburn interests.

A new cable railway on the Blue Line route was opened to traffic in Baltimore, Md., on May 22. This line is operated by a cable 22,535 ft. long. The company owns 40 miles of single track horse railway and proposes to supplant 23 miles of this by cable and operate the remainder by the trolley system.

The most serious railway accident of the week was the derailment of a circus train May 30, at McCann's Crossing, near Tyrone, Pa., on the Tyrone & Clearfield branch of the Pennsylvania R. R. The train, consisting of one engine and 14 heavy cars of the W. H. Main circus, was running on a down grade and was derailed at a sharp curve, the press dispatches giving a broken axle on one of the front cars as the cause of the disaster. All the cars except those occupied by the circus men went down a 30-ft. bank. Seven men were killed and nearly 20 more or less injured. A number of horses and other animals were killed and injured, and the circus vans and apparatus were completely destroyed.—In a freight train wreck on the Wisconsin Central Ry., at Gray's Lake, Wis., May 23, three tank cars of gasoline were smashed, and the gasoline caught fire. One man was burned to death and two were injured.

A trestle at Spring Branch, Tex., on the San Antonio & Aransas Pass Ry., was broken down by the derailed tender of a passenger train May 26, and the baggage car, mail car and smoking car went down; four persons were injured.—A new highway bridge across the Elkhorn River at Inman, Neb., gave way under a herd of cattle May 19.—A bridge on the Coeur d'Alene branch of the Northern Pacific R. R. near Saltese, Mont., gave way under a light engine May 18.

The engines of the Knoxville cable incline railway at Pittsburg, Pa., got beyond control May 24, and the cars ran into the bumpers with great force.

An explosion of gas in a sewer in Hanover, Rihl and Belgrade Sts., Philadelphia, Pa., May 29, blew manhole covers off and caused considerable damage to windows.

In noticing the Report of the Gas and Electric Light Commissioners of Massachusetts, in our issue of May 18, Mr. Wm. H. Olin was inadvertently accredited as secretary of the board instead of Mr. J. T. Leary, owing to the fact that the title page was followed by a letter of transmittal to the legislature through the Secretary of the Commonwealth.

The contract for dredging the Delaware River at Philadelphia has finally been awarded by Secretary of War Lamont to the American Dredging Co. for $3,403,780. It will be remembered that bids for this work were opened on Jan. 31 last, and the detailed bids were given in our issue of Feb. 9. The lowest bid was that of Coffey & Co., of Brooklyn, $2,987,750 for the total work. Owing to the delay of the previous contractor for the same work and his ultimate failure to carry out the terms of the contract the strictest inquiry was made by Major Raymond, the engineer officer in charge, as to the facilities of the bidders for conducting this work according to the terms fixed by the government. As the result of this investigation and the recommendations of Major Raymond the contract was awarded as above stated. The contract requires the American Dredging Company to excavate 21,500,000 cu. yds. at 14 1-5 cts. per yard; it deposits and spreads 2,000,000 cu. yds. of this on League Island for 16 cts. per cu. yd.; and it removes 16,200 lin. ft. of wharf, etc., for $1.90 per foot. The rate at which this work is to be done was given in full in this journal on Jan. 19, 1893. This is said to be the largest dredging contract ever let in the United States.

A fire from a most uncommon cause occurred on the lake steamer " Selwyn Eddy," while en route for Buffalo with a cargo of oats recently. The fire and smoke together damaged the cargo about 10 cts. per bushel on the average. It was suspected that the fire was set by the electric light wiring, and the owners of the vessel, very sensibly, had an investigation made by an electrical expert. His report states that the electric wiring was found to be in a good and safe condition, but that the evidence shows fire to have started in three different places, in each case in the vicinity of an electric lamp. In two instances the fire did so much damage that it was impossible to determine where it started, but in the third case the wiring and molding were intact, and only the lamp was destroyed. Putting with this the fact that grain was seen lodged on the molding above the lamps, the expert concluded that the hold was filled with grain until the lamps were covered up in it. Thus, the heat from the lamp was confined, and gradually accumulated until the grain was set on fire.

Cable cars on Broadway, New York city, began running on May 25 over the whole line. These cars and those on the Third Ave cable line (not yet in operation) are lit by the Pintsch gas system, and so far as we recall, are the first cable cars to be lit by gas.

The Chinese telegraph system has been connected with the Russian system, and every Chinese province excepting Hunan is now in telegraphic communication with the rest of the world. Hunan alone remains opposed to foreign innovations. There are now in all 167 stations with a rapid and satisfactory service, says Mr. Charles Derby, U. S. Minister at Peking. Since this connection has been made the cable companies have advanced their charges 15%; but messages may be sent over the Chinese lines at the former rate of $2 per word, the cost of transmission across the Atlantic being added.

The Siemens-Halske electric street railway line, in Budapest, with an underground conduit, has now been in successful operation for three years. It is a double-track road nearly 7 miles long, running 60 cars, with a seating capacity of 32 each, at an average speed of 12 miles per hour. This rate of speed can be doubled. The only interruptions to traffic have been of short duration and due to heavy snowfalls. The fare is 2½ to 4 cts., according to distance, with 6 cts. for transfer tickets. The company has obtained concessions for an extension of 3 miles. Mr. Edward P. T. Hammond, U. S. Consul at Budapest, gives the following non-official items relating to the construction and equipment of the road: Cost of excavation, masonry, paving, rails and switches, or roadbed, about $2,880 per mile of single-track; cost of cars, including motors, $6,000 each; weight of cars, including motors, 7 tons each; buildings, $15,000; five boilers and setting, $20,000; engines, dynamo, switchboard and all machinery, $70,000. The cost of running one car per mile is 5½ cts., including in this maintenance of track, labor at power stations, fuel, employes on cars, etc. The line has already been described in our columns.

Several projects for a new water supply for Toronto are on foot, one of the latest, in its present form, being that of the Toronto Aqueduct Co. This company proposes to bring water from Lake Simcoe and eventually from Georgian Bay to Toronto, and, in addition, to construct a ship canal 65 miles long, connecting Georgian Bay, Lake Simcoe and Lake Ontario, the water supply conduit to parallel the canal, according to reports. At a public popular meeting, held May 26, E. Choatsworth, M. P., S. G. Wood and others were appointed a committee to consider the project.

The commercial success of the Carbon Iron Co.'s direct process of iron manufacture has been greater than that of any other modern direct process. The process was described at length in our issues of Jan. 21 and March 24, 1888, and we have noted from time to time the remarkably high quality of the steel produced by the use of this material in the open-hearth furnace. As evidence of the commercial success which the company is achieving, it is announced that the Pittsburg Iron & Steel Engineering Co. is to erect some large additions to the Carbon Iron Co.'s plant, which will increase its capacity to about 350 tons of finished steel per day, the present capacity being about 225 tons.

The manufacture of rubber from cotton-seed oil is said to have been successfully accomplished by a Savannah, Ga., inventor, one John G. Carter, and a company has been formed under the title of "The Elastic Product Co." to exploit the process. The possibilities in the manufacture of tough and elastic substances from the vegetable drying oils are certainly considerable; witness, for example, the linoleum floor-covering manufactured from linseed oil. At the same time, such reports concerning the new enterprise as are published do not impress one favorably as to its genuineness.

The mounting for the Yerkes telescope is nearly completed by Warner & Swasey, of Cleveland, O., and it will be set up at the Chicago exhibition. The iron column supporting the telescope is 40 ft. high and 6 x 10 ft. in cross-section. The steel tube is 64 ft. long and 4 ft. in diameter; the largest spectroscope will be 9 ft. long, and the total length of instrument will be 73 ft. It will be handled through an electric keyboard. The floor of the observing room will be 70 ft. in diameter, and has a vertical movement of 20 ft., operated by hydraulic rams connected with the electric system of control. The steel dome covering the instrument will be 85 ft. in diameter, with the closing shutters also operated by electricity. The object glass is being made by Alvan Clark & Sons, of Cambridgeport, Mass., and is to be finished in December of this year. The electrical devices are an innovation.

A new method of lining and curbing shafts and wells is now being tried in Germany, says "Engineering." In this blocks of molded concrete are employed, which form segments of a circle or an oval, varying in size according to the dimensions of the shaft or well, and weighing from 8 cwt. to 12 cwt. each. These blocks have at each side a round fluting, with a channel at the top, and a corresponding but smaller semi-cylindrical roll or beading at the bottom; they have also two drill-holes, one running vertically and centrally, and the other horizontally from back to front at the base. The vertical drillhole enables a rod with a hook or ring to pass down and be intersected by a bolt running through the horizontal drill-hole, thus holding the rod and supplying the means of hoisting or lowering the blocks into their places. When A complete round of segments is formed (the blocks break joint like ordinary brickwork), the vertical flutings are rammed with a cementing material, and the space between the round and the natural wall of the shaft is packed with concrete. Before laying the next round of blocks, a thin layer of cement is placed in the channel on the top of the blocks beneath, into which the projection of the upper blocks fits, the joints thus becoming perfectly tight, and forming a solid lining through which water cannot penetrate. This system, it is said, has already proved a success in several colliery shafts in the Saarbrocken district, belonging to the Prussian government, which have been provided with linings in the manner described, with satisfactory results.

Cotton-seed which 30 years ago was thrown away as a waste product in the Southern States, or used as fuel, is now the basis of an industry valued at over $27,000,000 per annum. To-day the cotton-seed oil production is worth $16,000,000 per year, the oil-cake brings in nearly $8,000,000 more, and the lint and hulls produce $1,000,000. Only one-third of the seed is used as yet, the balance awaiting a wider market. The oil product is used in adulterating lard and olive oil, and the cake, lint and hulls in feeding stock as fertilizers. It is said that paper can be made from the stalks.

REMOVAL OF GRADE CROSSINGS AT ELIZABETH, N. J.; PENNSYLVANIA R. R.

In line with its established policy of improving its tracks in the larger towns along its main lines so as to reduce to a minimum all delay in handling its traffic the Pennsylvania R. R. Co. has been at work for some months raising its tracks in the city of Elizabeth, N. J., to do away with all crossings of the streets at grade. This work was begun late last summer, and when completed will give the company a four-track line through the town crossing all streets above grade. It may be noted here, also, that the Central R. R. of New Jersey, the only other railway entering the town, proposes a similar improvement in its tracks which when completed will make Elizabeth, N. J., a decided novelty in American towns, a city of 40,000 inhabitants, virtually without railway grade crossings.

The work which the Pennsylvania R. R. Co. has under way consists in raising all four tracks on an earth embankment for a distance of 1.8 miles from North Ave. to Bay Way Road. Work was first begun in August, 1892. The first move made was to abandon the two east tracks and throw all traffic on the two west tracks. A temporary trestle was then erected on the line of the abandoned tracks. This trestle conformed to the proposed grade of the new line and was constructed after the standard design of the Pennsylvania R. R. for wooden trestles. The main timbers were 12 × 12 ins.; yellow pine for stringers and hemlock for posts. The bents were placed 12 ft. apart c. to c. As soon as the tracks were laid the regular traffic was turned over the trestle and the two west tracks were abandoned and work on the permanent structure for this half of the line begun. The trestle was opened for traffic only within the last few weeks.

The permanent structure upon which work is now in progress will be substantial in all respects. It will consist of an earth embankment, except at street crossings, where stone masonry arches and plate girder bridges will be erected. There will be eight stone arches in all, two of 40 ft. span and six of 50 ft. span. Most of the arches will be built on a skew varying from 45° to 60°. Each arch is composed of a series of ribs or short right arches parallel to each other, the usual form of skew arch construction in this country. Only one-half of the arch, or the arch for two tracks only, is constructed at a time, the masonry being left toothed on the inner edge to allow the half-arch for the other two tracks to be joined to it. It will be seen that the ribbed arch readily lends itself to this form of construction, since each rib is erected entirely independent of the others. Sandstone is used for the arch masonry, part of which comes from the quarries at Osceola, Pa., and part from the well known brown sandstone quarries of New Jersey. There will be six plate girder spans, one 80-ft., two 30-ft., two 60-ft. and one 50-ft. The girders will be of the Pennsylvania R. R. Co.'s standard design for half-through girders, the top of the girder being 2 ft. above the top of the rail. A tight plank floor will be laid on the girder spans to prevent drippings from the tracks into the street below. The foundations for the plate girders consist of a masonry base supporting iron columns carrying the girders. No very deep excavation is required for the foundations since a firm gravel stratum underlies the soil only a few feet below the surface.

In connection with the elevation of the tracks the company will erect a new station. The plans for this station have not been completed yet, but it will be located near the crossing of the Central R. R. of New Jersey. Elevators will probably be used to convey passengers to and from the street and track levels. Work has only recently commenced on the permanent structure. The contractors are B. M. & J. F. Shanley, of Jersey City, N. J., and according to the company's contract with the city all work is to be completed by December, 1895. The total cost of the improvements will be about $300,000. The plans for the work were prepared by the engineers of the Pennsylvania R. R. Co., Mr. Wm. H. Brown, M. Am. Soc. C. E., Chief Engineer. Mr. Wm. C. Bowles is the Resident Engineer. We are indebted to Mr. Bowles for the information from which these notes are made.

THE ENGINEERING DEPARTMENT OF McGILL UNIVERSITY, MONTREAL.

McGill University, Montreal, is an institution of which Canada may well be proud, and owing to recent developments it now provides an education in engineering of the highest possible character. Three splendid buildings have recently been erected for the purpose of providing the means of a thorough training in theoretical, practical and scientific engineering.

The McDonald Engineering and Physics buildings and the Workman Mechanical Building were opened with appropriate ceremonies on Feb. 24 by Lord Stanley (now Earl of Derby), Governor-General of Canada, as noted in our issue of March 2. The Engineering and Physics buildings, with their equipments, have been presented to the University by Mr. W. C. McDonald, one of the leading and most esteemed merchants of the city of Montreal. The equipments are of the most elaborate and perfect description, and are equally complete in all the departments of civil, mechanical and electrical engineering.

The Workman Mechanical Building has been erected upon an endowment bequeathed to the University by the late Mr. Thomas Workman, another citizen of Montreal. The equipment of this building is also first-class in every respect, and this has been rendered possible by the contributions which have been generously given by the citizens of Montreal.

McDONALD ENGINEERING BUILDING, McGILL UNIVERSITY, MONTREAL.
Workshops in building on the left.

The Engineering Building is about 175 ft. long and from 55 to 60 ft. wide, with five floors. The Physics Building is about 150 ft. long and from 70 to 80 ft. wide, also with five floors. The workshops are about 130 ft. long by 50 ft. wide, of three floors, and with a floor area of about 25,000 sq. ft. The architect for both buildings was Mr. A. T. Taylor, M. R. I. B. A. The contractors were as follows: Lyall, masonry; Shearer & Son, woodwork of Engineering Building; G. Roberts, woodwork of Physics Building; Cowan, brickwork; Jordan & Locker, lavatories; Edison General Electric Co., Royal Electric Co. and Lea, Sons & Co. (England), electric lighting; Garth, plumbing and steam fitting. The buildings cost between $400,000 and $500,000 each, while the equipment in each represents about $250,000. The workshops are in a four-story annex to the Engineering Building, shown in the photograph.

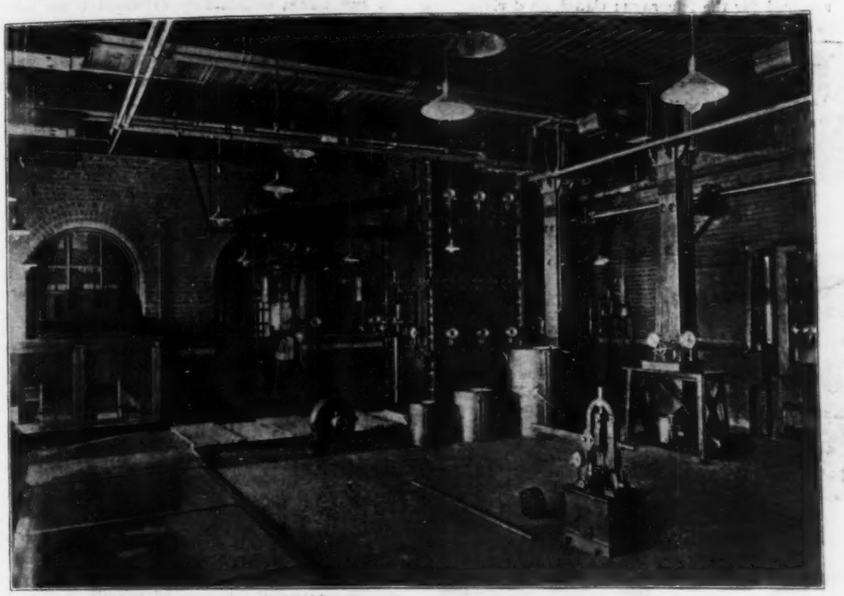
McGill University was founded under a bequest of Hon. James McGill, erected into a university by royal charter in 1821, and reorganized by an amended charter in 1852. There are six buildings, as follows: Arts Building, Medical Building, Museum, Engineering Building, workshops, and Physics Building. A library is also in course of erection. For the accompanying photographs and notes and for the following brief sketch of the history of the Faculty of Applied Science, we are indebted to Prof. H. T. Bovey, M. Inst. C. E., Dean of the Faculty of Applied Science:

In an inaugural address delivered in 1855 Sir William Dawson pointed out the importance to the university of a department of practical science. In the following year Mr. T. C. Keefer, C. E., was appointed Professor of Hydraulic Engineering, but was called away from Montreal without having entered on the duties of his office. At the same time Mr. Robert Crawford, B.A., was made Professor of Road and Railway Engineering, which position he held until the year 1857, when he was succeeded by Mr. Mark J. Hamilton, C. E., who held the post until the year 1865. The first graduate was Oliver Gooding, who in 1858 received the diploma of Civil Engineer, and the total number of graduates up to 1865, when the department lapsed, was 15.

In 1871 the department was re-established in connection with the Faculty of Arts, the special course of study required extending over three years and leading to the degree of Bachelor of Applied Science. The professors and lecturers appointed were Mr. C. F. Armstrong, C. E., now Professor of Engineering in the University of Edinburgh; Dr. Harrington, Dr. Girdwood and the late Dr. T. Sterry Hunt. Two years later, in 1873, Mr. C. H. McLeod, B. A. Sc., was added to the staff. In 1876 Professor Armstrong resigned, and was succeeded temporarily by Mr. C. A. Harris. In December of the same year Prof. Henry T. Bovey, M. A., Fellow Queens' College, Cambridge, was elected to fill the Chair of Civil Engineering and Applied Mechanics, and assumed the duties of his office in September, 1877.

In 1878 the department was separated from the Faculty of Arts and was constituted a Faculty of Applied Science, with Professor Bovey as Dean. The teaching staff, consisting of Professor Bovey, Dr. Harrington, Dr. Girdwood and Professor McLeod, was further strengthened by the addition of Mr. G. H. Chandler, M. A., as Lecturer (now Professor) in Mathematics. The course was also lengthened by adding to it a preliminary optional year, the complete course thus extending over four years and leading first to the degree of Bachelor of Applied Science, and subsequently to the degree of Master of Engineering, or Master of Applied Science. At this time 28 students were attending the various courses, and the number steadily increased to 75 in 1890. In that year a new career was opened up for the Faculty by the series of munificent endowments of Mr. W. C. McDonald and the late Mr. Thomas Workman, supplemented by the liberal gifts of other citizens, and the number of students suddenly rose to 125 in 1891, and to 175 in 1892. Meanwhile the efficiency of the university teaching staff was considerably increased by the appointment of J. Cox, M. A. (McDonald

Professor of Experimental Physics); C. A. Carus-Wilson, M. A. (McDonald Professor of Electrical Engineering); J. T. Nicolson, B. Sc. (Workman Professor of Mechanical Engineering); W. A. Carlyle, Ma. E. (Lecturer in Mining and Metallurgy); R. S. Lea, Ma. E. (Lecturer in Mathematics and Drawing); and N. N. Evans, M. A. Sc. (Lecturer in Chemistry).



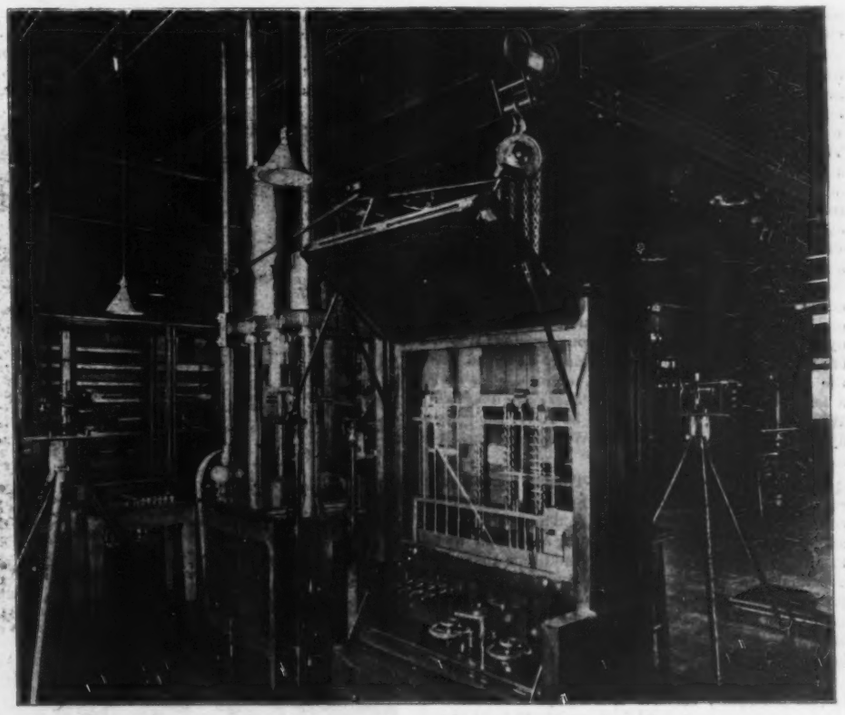
HYDRAULIC LABORATORY, SHOWING PROF. BOVEY'S IMPACT APPARATUS.

Hydraulic Laboratory.—This is a room 39 × 31 ft. and contains a large experimental tank and five gaging tanks, each of the latter having a capacity of about 250 cu. ft. The tanks are being very carefully calibrated both for weight and volume, and the amount of water in any one or in any number of the tanks may be estimated by means of a specially designed indicator. The large iron experimental tank in sections, with outside flanges, discharges into a watercourse about 40 ft. long by 4 ft. wide, which can be divided up into compartments and at the end of which the water is discharged over weirs of variable form into the measuring tanks. For high pressure experiments a stand-pipe giving a head of 250 ft. has been installed. From this stand-pipe, pipes from 6 ins. down to the smallest size can be laid for a distance of 600 ft., thus rendering possible experiments on the vertical flow of water in pipes.

Besides a very large collection of nozzles, mouthpieces, weir gaging apparatus, a specially designed depthing machine, an impact machine designed by Professor Bovey for measuring the force of a jet of water, gages of every description, a Venturi water meter and other water meters. There are also turbines and Pelton water motors, the Halpin brake for measuring the power of water motors, etc. The laboratory is also being supplied with a set of experimental pumps designed to work under all pressures up to 120 lbs. per sq. in. and at all speeds up to the highest. The pumps are to have interchangeable sets of valve chests, etc.

Testing Laboratories.—These consist of two large rooms each 60 × 32 ft., with a basement of the same size. The main apparatus contained in these laboratories consists of a 75-ton Emery machine; a 100-ton Wicksteed testing machine, and Unwin's machine for torsional, transverse and tensile testing. The machines are supplied with a working average up to 3,600 lbs. per sq. in., and may be worked either direct from the pumps or by means of an accumulator. The equipment also includes various kinds of extensometers, Boehme's hardness apparatus, Whitworth's 100,000-lb. machine, Sweet's measuring machine and a very complete collection of micrometers; also an Oertling bullion balance, with standard weights up to 100 lbs.

The whole of the pressure pipes are on one circuit and connected with an Emery standard gage reading from 0 to 2,400 lbs. per sq. in., and single pounds may be readily estimated. There are also various recording gages. To the Wicksteed machine is being attached a self-registering apparatus similar to that used by Professor Martens' laboratory in Charlottenberg. An impact apparatus is being constructed, fitted with revolving drum, tuning fork, etc., for recording the effects of repeated strokes under varying pressures. The equipment also includes a specially designed cathetometer, and all the necessary apparatus both for preparing specimens for testing and for the scientific observations connected with the tests.



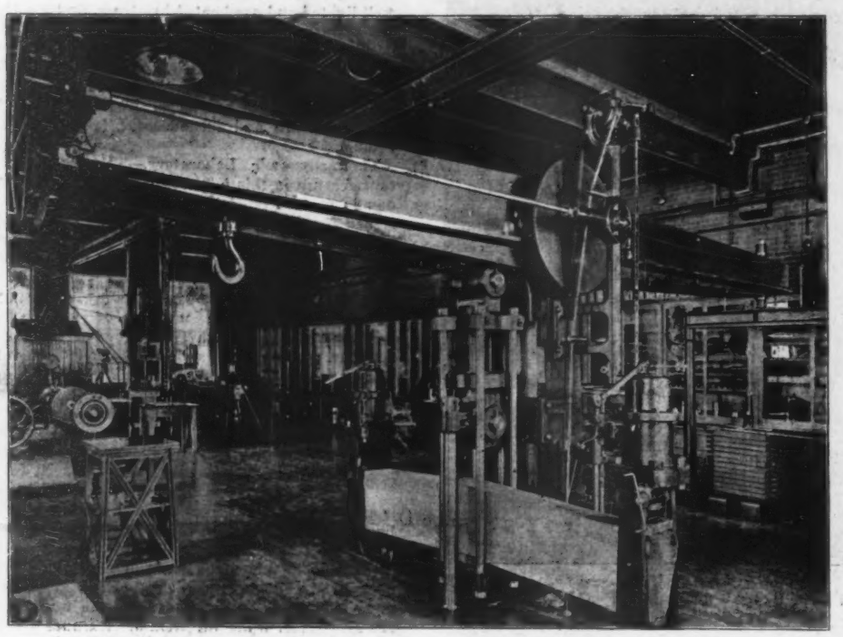
TESTING LABORATORY, SHOWING EMERY MACHINE.

Mechanical Workshops.—These are in an annex to the main building, and include the following departments: 1. Boiler-house, with four Babcock & Wilcox water tube boilers and a Yarrow (English) tubulous boiler, of the type used for torpedo boats. 2. Engine-room, with horizontal tandem compound engine which furnishes power for the shops. The engine was built by Laurie Bros., of England, has cylinders 8 × 16 ins. and 14 × 16 ins., and is of 50 HP. 3. Machine shop, well provided with tools. 4. Smithy. 5. Foundry for brass and iron castings. 6. Wood turning and pattern-making shop. 7. Carpenter shop. The rooms are well lighted and are heated by steam, and the tools and plant are arranged to good advantage. Power is taken by belting from the overhead line shafting. The building is of brick, with heavy timber columns and beams, the heads of the columns being fitted with iron caps. The electric light, with both arc and incandescent lamps, is fitted throughout.

Thermodynamic Laboratory.—The most important feature in this laboratory is the four-cylinder double tandem 80-HP. steam engine, specially designed for the university by Messrs. Schoenheyder and Druitt Halpin, of London, and manufactured by Yates & Thom, Blackburn, England. The four cylinders are 6½, 9,, 13 and 18 ins. diameter and 15 ins. stroke. The engine is arranged to work in a large number of totally different ways under a maximum pressure of 200 lbs. per sq. in. and at about 150 revolutions per minute. The two engines may be uncoupled from each other and run at different rates of speed, so that the advantages of variation of relative cylinder volume are to some extent obtained. The power is measured by means of two hydraulic brakes, designed by Froude and improved by Osborne Reynolds, while an alternative method is also supplied by an excellent rope brake kept cool by a stream of water on the inner side of the wheel rim. The steam pipes are all of copper and are so arranged that the engine may run with either quadruple, triple, double or single expansion. Very complete arrangements for measuring the water used are also made, while variation of clearance volume is provided on the low-pressure cylinder by means of pots having movable pistons. The steam for this engine is supplied by a water-tube boiler of the Yarrow type, the forced blast being supplied by means of a 5-HP. Sturtevant blower. For pressures up to 120 lbs. four 60-HP. Babcock & Wilcox boilers are available.

In addition to the above there are also in this laboratory an 80-HP. Robb-Armstrong automatic cut-off engine; a 10-HP. Woodbury-Merrill Stirling type of hot air engine; a 6-HP. Atkinson cycle gas

engine, and a 4-HP. Otto gas engine; all completely equipped for experimental purposes. A 40-HP. experimental double air compressor is also being made. The 50-HP. compound tandem engine made by Laurie Bros., and furnishing power for the line shafting in the shops, is also available for experimental work. There is also a large collection of



TESTING LABORATORY, SHOWING WICKSTEED MACHINE.

Crosby, Thomson and other indicators; Barrus, Donkin and other calorimeters; gages of all kinds, and all the necessary apparatus for the complete equipment of an experimental laboratory.

Electrical Laboratories.—The laboratories connected with the electrical engineering course are as follows: 1, electrical laboratory; 2, magnetic laboratory; 3, photometer-room; 4, electrical workshop; 5, dynamo-room; 6, lighting station. The principal instruments in this department are a complete set of Thompson's apparatus; for example, galvanometer, electrical balances, electrostatic voltmeters, etc. Also Siemens' dynamometers, Weston ammeters and voltmeters, D'Arsonval galvanometer. Ayrton secohmmeter, Nalder ammeters and voltmeters, standard ohms, cells, etc.; ballistic galvanometers Ewing's magnetic curve tracer, Hopkinson's yoke, traction apparatus, etc. A large and valuable photometer, experimental dynamos (Edison, Brush, Thomson-Houston, Wood, etc.) Mordey's transformer, specially designed for the laboratory; also generators, motors, etc., and a self-contained lighting plant. There are also two Williams engines, one driving a 30-K-W. Siemens' dynamo, and the other a 30-K-W. Edison-Hopkinson dynamo.

Cement Testing Laboratory.—This is completely equipped with the most perfect appliances for cement and mortar testing. The best examples of testing machines, both American and English are represented, and in addition there is a transverse testing machine, and a hydraulic press specially designed for compressive experiments. The laboratory has also a large number of copper-lined cisterns, in which briquettes may be submerged for any length of time.

Geodetic Laboratory.—The principal apparatus in this laboratory consists of a comparator for investigating standards of length up to 40 ins.; also a comparator for estimating lengths up to 50 ft. There are also a circular dividing engine; a linear dividing engine, with a cross stroke of 6 ins. and graduated up to 42 ins.; Bessel's reversible pendulum, an astronomical clock, end measuring gages and mining instruments. In the Surveying Department there is a large collection of different kinds of levels, sextant plane tables, current meters, an altazimuth, a zenith telescope, transit instruments, hand levels, pedometers, etc.

LOCKS OF THE NICARAGUA CANAL AND THE ST. MARY'S FALLS CANAL.

By E. S. Wheeler, U. S. Asst. Engr.

In this article it is intended to present a discussion of the number, dimensions and cost of locks required for the Nicaragua Canal, as derived from the actual results of the St. Mary's Falls Canal, in this country.

There are two locks in the St. Mary's Falls Canal. One of them is now being built, and it is expected will be completed in three years. About one-half of the masonry is now laid, and the floor and culverts are under contract. The other lock

MATHEMATICAL LABORATORY.

was completed in 1881, and has been in use ever since, and is now the only lock connecting Lake Superior with the lower lakes. All of the parts of these locks have been subjected to a careful theoretical analysis wherever possible. The lock now in use has been subjected to a further practical test. Since its opening in 1881, it has made 42,974 lockages. There have passed through it 87,996 vessels, carrying 63,944,121 tons of freight, valued at $863,820,000. The total cost of operating the lock during this time has been $372,172, which includes all repairs, and it is in better condition now than when first opened. This work, it is believed, is sufficiently satisfactory to warrant the use of actual data taken from this lock without any further theoretical discussion. The following facts concerning the construction, use, cost, etc., of the St. Mary's lock will be used for data in this paper.

During the month of July, 1892, there passed through this lock 1,926,210 net tons of freight. This gives an annual rate of 22,695,100 tons. During the months of June, July, August and September, 1892, there passed through the lock 7,032,127 net tons of freight; this gives an annual rate of 21,053,138 tons, and the lock was not used to its full capacity. The dimensions of the lock now in use are: Length between gates, 515 ft.; width, 80 ft., narrowed to 60 ft. at the gates; mean draft during the season of 1892, 14.6 ft.; mean lift during the season of 1892, 18.6 ft.

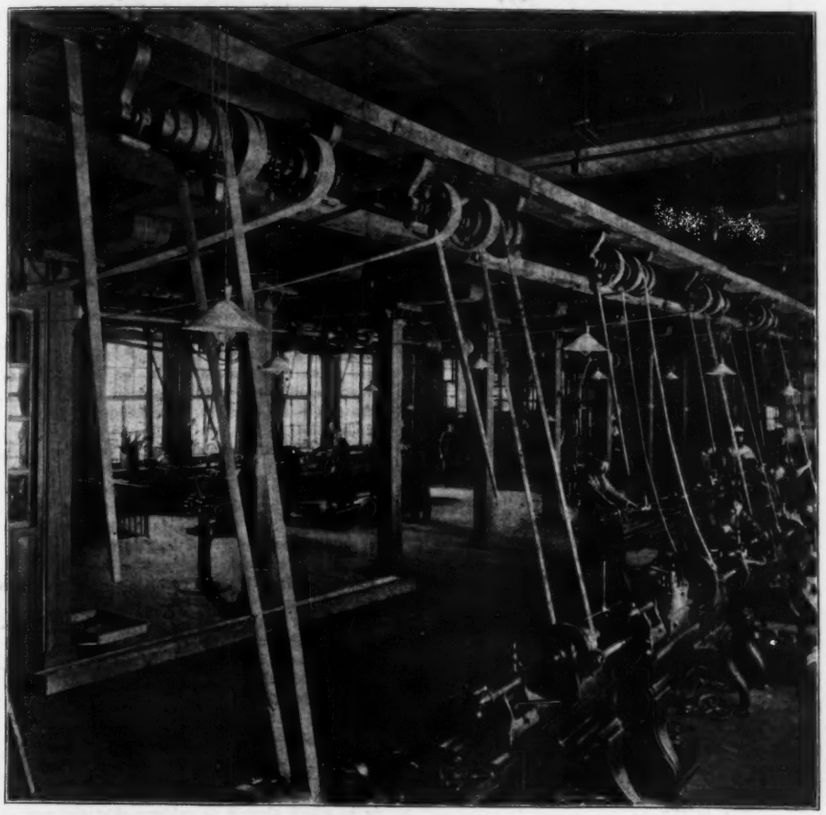
The water is admitted into the lock through two wooden conduits; these conduits are 8 ft. square and pass through the miter wall and lie under the floor of the lock, and extend nearly the whole distance between the lock gates. There are 29 small holes in the upper side of each conduit, distributed uniformly through the entire length. The water passes vertically upward through these holes into the lock chamber. The conduits are provided with valves at their upper ends. The water is let out of the locks through similar short conduits passing under the lower lock gates; these conduits are also provided with valves. This system was designed to prevent the dangerous disturbance of vessels in the lock while water was being admitted. It completely and perfectly accomplishes its purpose, and there can be no better system, except as it works more rapidly or is cheaper. So far as rapidity is concerned, this will be largely increased in the lock now building, in which there will be six similar conduits. These conduits are called culverts. The average time required for filling the lock now in use is 12 minutes, and, for emptying, 8 minutes.

The floor and culverts of the St. Mary's locks are of timber and concrete bolted to the rock foundation. The cost per square foot of surface covered by both floor and culverts was $2.38 for the lock now in use. The contract price for the lock now building is $2 per sq. ft. The former, being actual, completed work, will be used in this paper. The cost of bolting alone is 45 cts. per sq. ft.

There are two kinds of masonry used. The facing of the lock chamber to an average depth of 4 ft., the coping to an average depth of 2 ft.; the

entire miter wall and the lining of the gear passages are called "cut stone"; the remainder is called "backing." The contract price for cut stone masonry in the lock now building amounts to $27.84 per cu. yd. The same for backing is $8.10 per cu. yd., and for concrete $6.52.

The lock walls in the vicinity of the gates are built wider than elsewhere, and with vertical sides, so as to give sufficient weight to resist the thrust of the gates; the part between the miter walls is 10 ft. wide on top, and has a batter at the back of 4.9 perpendicular to 1 horizontal; for the lock now building it is 4.4 perpendicular to 1 horizontal. In the lock now in use the width at the gates is 60 ft., and the width of the wide wall is 39% greater than that of the narrow wall at the bottom. In the lock now being built the width at the gates is 100 ft., and the wide wall is 80% wider than the narrow wall at the bottom. The length



MACHINE SHOP.

of the wide wall for each gate is 4 ft. more than the width of the lock. The thickness of the miter walls is 12 ft.

The gates are made of oak, with ties and straps of iron; they have a very large factor of safety and have resisted heavy blows from vessels. They have been opened and closed more than 50,000 times. About one minute is occupied in either opening or closing. They have never been out of order or failed in any way to do the work required of them. It is difficult to see in what way their efficiency could be improved. The cost of one leaf of lower gate is $7,300.

It is believed by the writer that the cost of construction could be reduced perhaps 20%, and danger of collision with vessels almost wholly removed, by building the gates with a factor of safety for water pressure alone, and then properly placing movable chain barriers across the lock just above and below the gates.

The metal work of the lock now in use cost $83,800. This includes gate anchorages, snubbing hooks, valves, pumps, machinery and machine-house. The cost of a valve is about $2,000 and of a gate anchorage of the lock now in use about $700.

The machinery for operating gates and valves is as follows: The power is obtained from two turbines. Water is brought to them from the canal above the locks through a supply pipe 36 ins. in diameter. The turbines are geared to a main shaft, a belt from which runs two force pumps which pump water into an accumulator loaded so as to give a pressure of about 120 lbs. per sq. in. Water is taken from the accumulator through pipes to hydraulic engines which open and close the gates and valves. This machinery has proved thoroughly adequate, and similar machinery will be placed in the locks now building.

It is believed by the writer that the cost of the machinery can be reduced and the efficiency maintained by using capstans and cables instead of hydraulic engines and water pipes, and by transmitting power electrically instead of by water under pressure.

The cost of engineering, superintendence and office work of the lock now in use was 8% of the total cost. The cost of operating the lock now in use has averaged $33,715 per year, including all repairs. If this amount be capitalized at 6% it will represent $562,000. The area of the lock chamber is about 40,000 sq. ft.

The average time of making a locking is 40 minutes. Of this ten minutes are occupied in either filling or emptying the lock, two minutes in opening and closing the gates and the remaining 28 minutes are occupied by the vessels in entering and leaving the lock. The average number of vessels in a locking is two, very nearly. The miter walls are 12 ft. wide from top to bottom; their height is 30 ft. (18 ft. is for the lift and 12 ft. is below the floor; it is through this part that the culverts pass).

The preceding data will be used to determine as far as possible the most desirable number of locks for the Nicaragua Canal and their cost. It will be assumed that the locks and canal are to be built as a purely commercial enterprise. The investigation will be confined entirely to the locks, therefore no estimate for the excavation, either for canal or locks, will be included. It will be assumed that the locks have a rock foundation, but that the rock is not of a suitable quality to be left in situ for the walls. These are the conditions of the St. Mary's locks. It is not supposed that all of the conditions here assumed will correspond to those which will be found to actually exist in the Nicaragua Canal. It is proposed to determine the cost, dimensions, etc., of a system of locks with given conditions. This will serve as a basis to which corrections can be applied when the actual conditions are known.

The following dimensions will also be assumed: Length, 600 ft. between gates; width, 70 ft.; draft, 25 ft. These dimensions are chosen because there are only a few vessels now afloat the length of which exceeds 600 ft., a few others with a beam which exceeds 70 ft. and still a few others that might load to a greater draft than 25 ft. It is believed that the commercial importance of these three classes is so small that it would not be profitable to build locks to receive them. If, however, the dimensions should be much farther reduced, it is believed that more would be lost in business than would be saved in cost. In locks of different sizes that are equally well proportioned it may be assumed that their capacity for doing business is approximately proportional to the product of their areas and draft; this product for the lock under discussion exceeds by 80% that of the St. Mary's locks now in use, which, as before stated, has already done business at the rate of more than 22,000,000 tons annually. The dimension remaining to be determined is the lift, and this depends on the number of the locks.

The elevation of Lake Nicaragua will be taken as 110 ft. above the sea. There must therefore be two similar sets of locks, each having a total lift of 110 ft. This could be accomplished with two locks, each having a lift of 110 ft., or with four locks, each having a lift of 55 ft., or with six locks, each having a lift of 36.7 ft., or with eight locks, each having a lift of 27.5 ft., or with 10 locks, each having a lift of 22 ft., or with 12 locks, each having a lift of 18.3 ft., or any other greater number of locks, but the practical limits are included in the above list. The only lifts that need be considered are those given above.

It is true that a set of locks could be built with different lifts in each lock, but this arrangement, so far as the locks alone are concerned, would not be economical, since the canal can do no more business than the least efficient one of its locks. In selecting from the above systems of locks the most desirable one, both cost and efficiency must be considered.

The cost of the above systems will first be determined, and for more convenient analysis the cost will be separated into four principal parts: 1. Cost of floors and culverts. 2. Cost of side and miter walls. 3. Cost of gates. 4. Cost of metal work.

For convenience the locks on one side of Lake Nicaragua will be called a "set," and those on both sides will be called a system. In any set of locks, the upper ones can be drained into the lower ones, so that only two guard gates are necessary, one above the upper lock and one below the lower lock. If the locks are not grouped well together this might not be sufficient, but for this discussion it will be assumed that it is; therefore, each lock will have only two gates, and the total length of the side walls will be 700 ft. By referring to the dimensions of the St. Mary's locks, already given, and making proportionate reductions to correspond with the dimensions assumed for the locks under consideration the following general dimensions have been determined:

Number of culverts	4
Length of lock floor	700 ft.
Width of lock floor	70 "
Height of side walls = lift + draft + 4 ft.	
Total length of side walls	700 "
Length of narrow part	552 "
Width of narrow part on top	10 "
" " " bottom = 10 ft. + 22% of height.	
Length of wide wall	148 "
Width " " " = 15 ft. + 32% of height.	
Draft	25 "
Length of miter wall on curve	75 "
Height of miter wall = lift + 12 ft.	
Width of miter wall = ⅔ lift.	

With these dimensions the amount of material in the several systems of locks has been computed; then with the unit prices, as previously given, the cost has been determined.

It is believed that increased lift would cause no change in any part of the floor or culverts, except increased bolting (at least up to a lift of 55 ft.). It has therefore been assumed that the cost of bolting would increase directly with the lift.

With this assumption the cost of floors and culverts is as shown in the third column of Table 1.

The cost of the side and miter walls is shown in columns 4, 5 and 6. The fourth column gives the cost when cut stone and backing are used as in the St. Mary's locks. The fifth column gives the cost when backing alone is used, and the sixth when concrete is used.

The side walls of the St. Mary's canal are of wood and earth; they join the masonry of the lock walls about 50 ft. above and below the guard gates.

TABLE I.

No. of locks in the system.	Lift in each lock.	Cost of floors and culverts.	Cost of masonry. When cut stone and backing are used.	Cost of masonry. When backing alone is used.	Cost of masonry. When concrete alone is used.	Cost of gates.	Cost of metal work.
2	110.0 ft.	$503,000	$6,598,000	$4,306,000	$3,450,000	$2 741,000	$316,000
4	55.0 ft.	692,000	5,908,000	3,706,000	2,968,000	1,306 000	491,000
6	36.7 ft.	884,000	6,108,000	3,876,000	3,061,000	872,000	665,000
8	27.5 ft.	1,076,000	6,456,000	4 000,000	3,204,000	710,000	816,000
10	22.0 ft.	1,265,000	6,918,000	4,2 0,000	3,398,000	630,000	1,012,000
12	18.3 ft.	1,449 000	7,502,000	4,562,000	3,656,000	586,000	1,186,000

This junction affords a convenient point for comparing the relative durability of wood and masonry. The lock has been in use 11 years. At present the wooden walls seem to be in better condition at all four points of junction than the adjacent masonry walls. Similar wooden walls have been built for $2.80 per cu. yd. The writer believes that the cost of lock walls could be diminished and their durability increased by a judicious combination of wood and concrete.

The cost of gates, when the width remains constant, is assumed to vary as the product of the height and pressure. With this assumption and the details which have already been given for the St. Mary's locks, Column 7 has been determined. This column shows the cost of gates for the several systems when there are two gates for each lock and two guard gates for each set of locks.

Column 8 shows the cost of metal work. The strength and cost of the valves and anchorages to lower lock gates and the number and cost of the snubbing hooks must increase with the lift. The other parts of the metal work might remain the same for all lifts. It is estimated that the cost of valves, anchorages and hooks would be twice as much for a lift of 55 ft. as for one of 18.3 ft. With this assumption, and the details already given for the St. Mary's locks, Column 8 has been found.

This table has been derived from work actually done in which all contingencies have been provided for. It does not, however, include the cost of engineering, superintendence and office expenses. On the St. Mary's lock these were 8% of the total. If the different items be summed and 8% added, Table II. is found:

Table II.

No. of locks in system.	Lift in each lock.	Cost when cut stone and backing are used. Cut stone.	When backing alone is used. Backing.	When concrete alone is used. Concrete.
2	110.0	$10,937,000	$8,501,000	$7,5 7,000
4	55.0	8,961,000	6 691,000	5,894,000
6	36.7	9,211,000	6,747,000	5,924,000
8	27.5	9,776,000	7,124,000	6,264,000
10	22.0	10,611,000	7,719,000	6,8 9,000
12	18.3	11,581,000	8,406,000	7,427,000

This table shows the total cost of construction for six different systems. It shows, so far as construction is concerned, that the system in which there is a lift of 55 ft. in each lock is cheaper than any other. It also shows that the cost of locks made with concrete walls is about two-thirds of the cost of those made with masonry having cut stone in the manner of the St. Mary's locks. It is believed that concrete would be sufficiently durable for commercial purposes; therefore, that material will be considered in this discussion. It has been previously stated that the cost of operating and care of St. Mary's locks, when capitalized, represents $562,000. Since this is practically proportional to the number of locks the total cost of constructing and operating, when concrete is used, would be as in Table III.:

Table III.

Number of locks in system	Lift of each lock in system.	Total cost of system, constructing and operating.
2	110.0	$8,711,000
4	55.0	8,142,000
6	36.7	9,296,000
8	27.5	10,760,000
10	22.0	12,429,000
12	18.3	14,171,000

This table also shows that the cost is least in that system where the lift is 55 ft., or where there are four locks in the system, two in each set. It will be seen that the cost where there are two locks in the system, one in each set, with a lift of 110 ft. each, is not much greater. It is believed, however, that a lock with so great a lift as 110 ft. (making a pressure of nearly 48 lbs. per sq. in.) could not be built with the proportionate cost given in the table, because some parts of the material, notably in the gates, would have to be replaced with other material of greater strength. This system will not therefore be farther considered, but for a lift no greater than 55 ft., it is believed that the material in the St. Mary's locks would be strong enough by simply proportionately increasing the amounts as has been done.

It now remains to consider the relative amount of work which can be done by different systems, and the probable value of such work. In any system of locks it is assumed that the locks are all equal in capacity; therefore all the boats that can pass the first lock in the system can be passed on by the remaining locks in the same time, and therefore the capacity of any such system is the capacity of one of its locks. A lock with small lift can be filled and emptied quicker and its gates and valves opened and closed quicker than a lock with a great lift. Therefore when the total lift is constant a system with many locks has greater capacity for doing work than a system with few. The amount of this difference can be quite definitely determined. The locks under discussion have an area of about 42,000 sq. ft. and four culverts. With a lift of 18.6 ft., from data already given, it will be seen that it could be filled or emptied in 5¼ minutes. Since the time of filling or emptying a lock of given area varies as the square root of the lift, the following table can be determined:

Table IV.—Time of filling or emptying a lock with lift of:

55.0 ft.	9.028	minutes.
36.7 "	7.375	"
27.5 "	6.384	"
22.0 "	5.710	"
18.3 "	5.208	"

In the locks under consideration there seems to be no reason why vessels should not enter and leave in the same time with any lift. It is, however, not possible to operate the massive machinery necessary for a high lift as quickly as the lighter machinery of a low lift; this difference would not be large, and would depend upon the character of the machinery. It is estimated that it would take one minute longer to open or close the gates and valves of a lock with 55 ft. lift than it would of lock with 18 ft. lift, and that this difference varies with the lift. With this assumption the following table is made, using data already given:

Table V.—Time of making locking in lock, with:

55.0-ft. lift.	40.028	minutes.
36.7 " "	37.872	"
27.5 " "	36.632	"
22.0 " "	35.810	"
18.3 " "	35.208	"

Since the time of locking is a direct function of the amount of work that can be done, this table can be put in the following form, which shows the percentage of work possible for different locks when the work done by a lock with a lift of 55 ft. is represented by 100:

Lift.	Work.	Cost.
55.0	100	100
36.7	106	101
27.5	109	103
22.0	112	105
18.3	114	106

This table shows that the efficiency increases as the lift diminishes, so that a lock with a lift of 18.3 ft. can do 14% more work than a lock with a lift of 55 ft.; but since the cost of a system of locks increases as the lift diminishes a third column has been added, showing the percentage of cost. To obtain this, the total cost of the canal has been assumed to be $100,000,000 when the locks in the system have a lift of 55 ft. each.

It is seen from this table that the efficiency of a system in which the lift is 36.7 ft. is 6% greater than in a system in which the lift is 55 ft., while the cost is only 1% greater. Similarly, when the lift is 18.3 ft. the efficiency is increased 14%, while the cost is increased only 8%. If this were the only way of increasing the efficiency it might be well to consider it, but an inspection of the table will show that a duplicate system of locks with lift of 55 ft. could be built and operated with a cost of less than 9% of the total cost of the canal. This would give an increased efficiency of 100%, for the canal can easily do the business of two systems of locks. The necessity for a duplicate system of locks in the St. Mary's canal has for several years been so apparent that it has become almost a national question, and the government is pushing forward the second lock with the most liberal appropriations. Exactly the same necessity would exist in the Nicaragua Canal. It therefore appears that when efficiency is considered with reference to the cost of the entire work a duplicate system in which the lift is 55 ft. is the best. There is still another important element affecting the number of locks, and consequently the lift, and that is the excavation. Under the ordinary topographical and geological conditions the cost of the excavation would diminish as the number of the locks increased. Since the question of excavation is not here discussed, the most desirable number of locks where all elements are considered is not yet reached. It is believed, however, that it will be found to be some number greater than has been found by this discussion, in which the construction and operation of the locks have alone been considered.

The preceding results have been obtained, not from theory, but work which has actually been done and very thoroughly tested. The transformation from the conditions of the St. Mary's locks to the proposed form of the Nicaragua locks is so simple an arithmetical operation that it is believed no important corrections are possible. These practical results may have an interest from the fact that there is no other lockage system with which any adequate comparison could be made. Since the work upon which this discussion is based has been done at Sault Ste. Marie, it follows that the cost as deduced need not be exceeded in any similar locality; on the other hand, it does not prove that the work could not be done cheaper. It is believed, however, that it could not be done much cheaper. No attempt has been made to determine the relative cost of work on the St. Mary's and the Nicaragua canals, since the writer has no special information upon this matter. The estimate of $100,000,000 for the entire Nicaragua Canal has been taken from engineering periodicals, newspaper reports, etc.; the writer has no special means of judging of the value of this estimate; if it should be found necessary to modify it, the conclusions which depend upon it should be correspondingly changed. The small relative cost of the locks (less than 6% of the total cost of the canal) is noticeable. The fact that four locks would be cheaper (so far as the locks alone are concerned) than any other number is also noticeable. The difference in the cost of systems in which there are four, six and eight locks is so small that it is evident that the cost of excavation will be the governing factor in determining the most economical number. It is possible that a system with ten or even twelve locks might be found cheapest. It is possible, and even probable, that the topography and grade on the two sides of Lake Nicaragua would differ so much that it would be economical to have a different number of locks in each set. The fact that the efficiency of a canal, in which there is a given lift to overcome, increases with the number of locks is obvious, though it might be overlooked.

The necessity for a duplicate system of locks has been made conspicuously apparent to those using and depending upon the St. Mary's Canal. The same necessity will exist in the Nicaragua Canal. One more conclusion can be derived with great weight from the actual results of the St. Mary's Canal, though it is not directly connected with this discussion which will be given here:

There seems to have been, at least with the French engineers, an impression amounting almost to a conviction that a canal without locks was very much more valuable than one with locks. This is quite erroneous, as can be clearly shown from the results of the St. Mary's Canal. The average time required for boats to pass this canal, as shown by the last 20,000 passages, is 3 hours 35 minutes. The canal is 1.6 miles long, and boats passing it move about four miles per hour; therefore, 24 minutes of this time would be required if

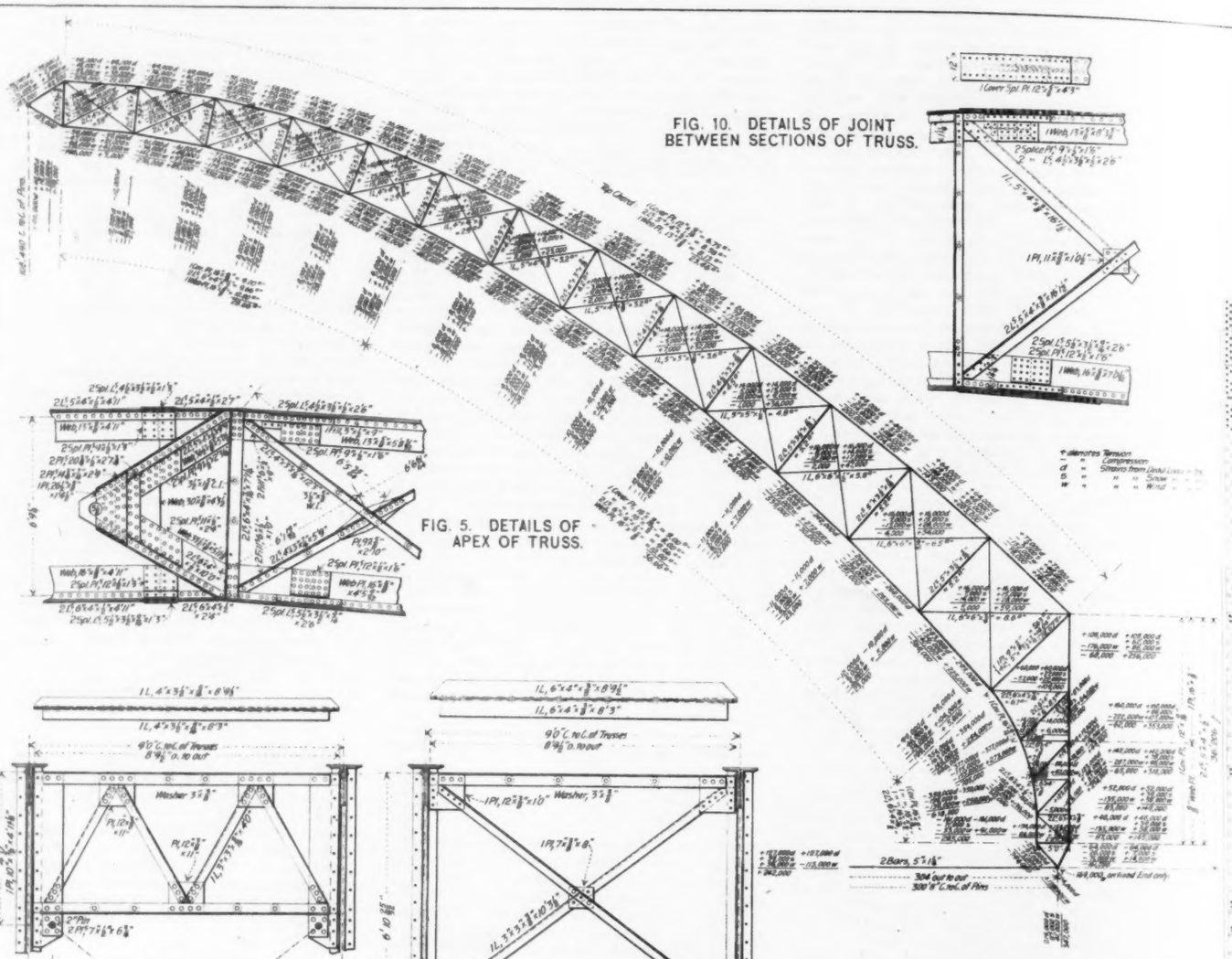
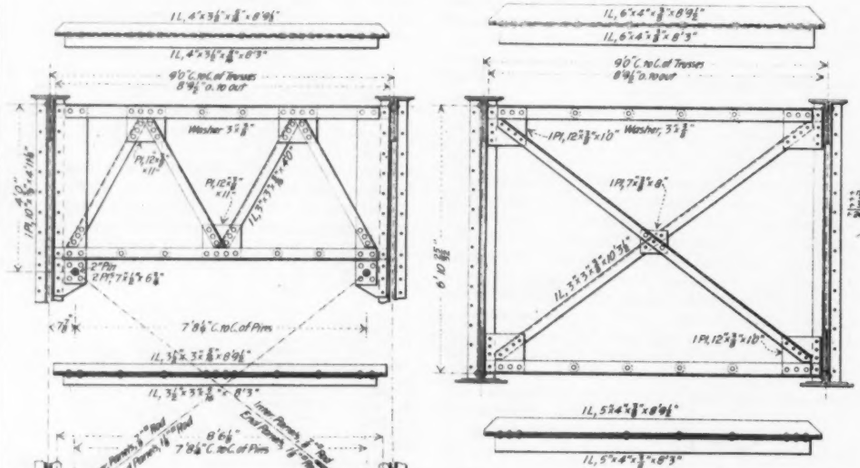


FIG. 10. DETAILS OF JOINT BETWEEN SECTIONS OF TRUSS.

FIG. 5. DETAILS OF APEX OF TRUSS.

FIG. 13. STRAIN DIAGRAM OF INTERMEDIATE TRUSS.



FIGS. 1 & 2. DETAILS OF CROSS FRAMES AND ARCH PURLINS.

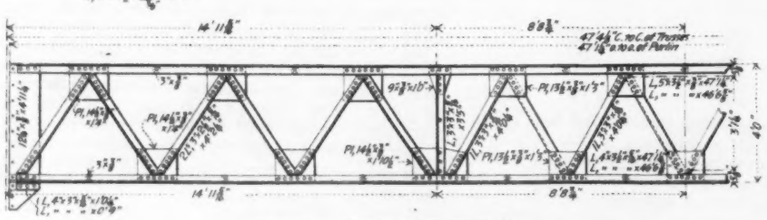


FIG. 11. DETAILS OF PURLIN.

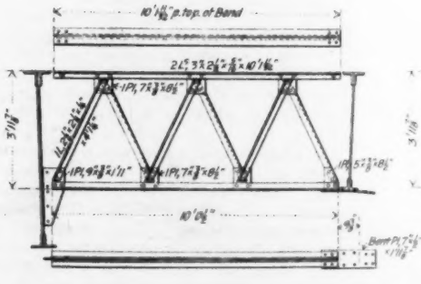


FIG. 12. DETAILS OF PURLI

THE BROAD STREET STATION TRAINSHED OF

Wm. H. Brown, Chief Engineer, and Wm. A. Pratt, Engi
Pencoyd Bridge & Co

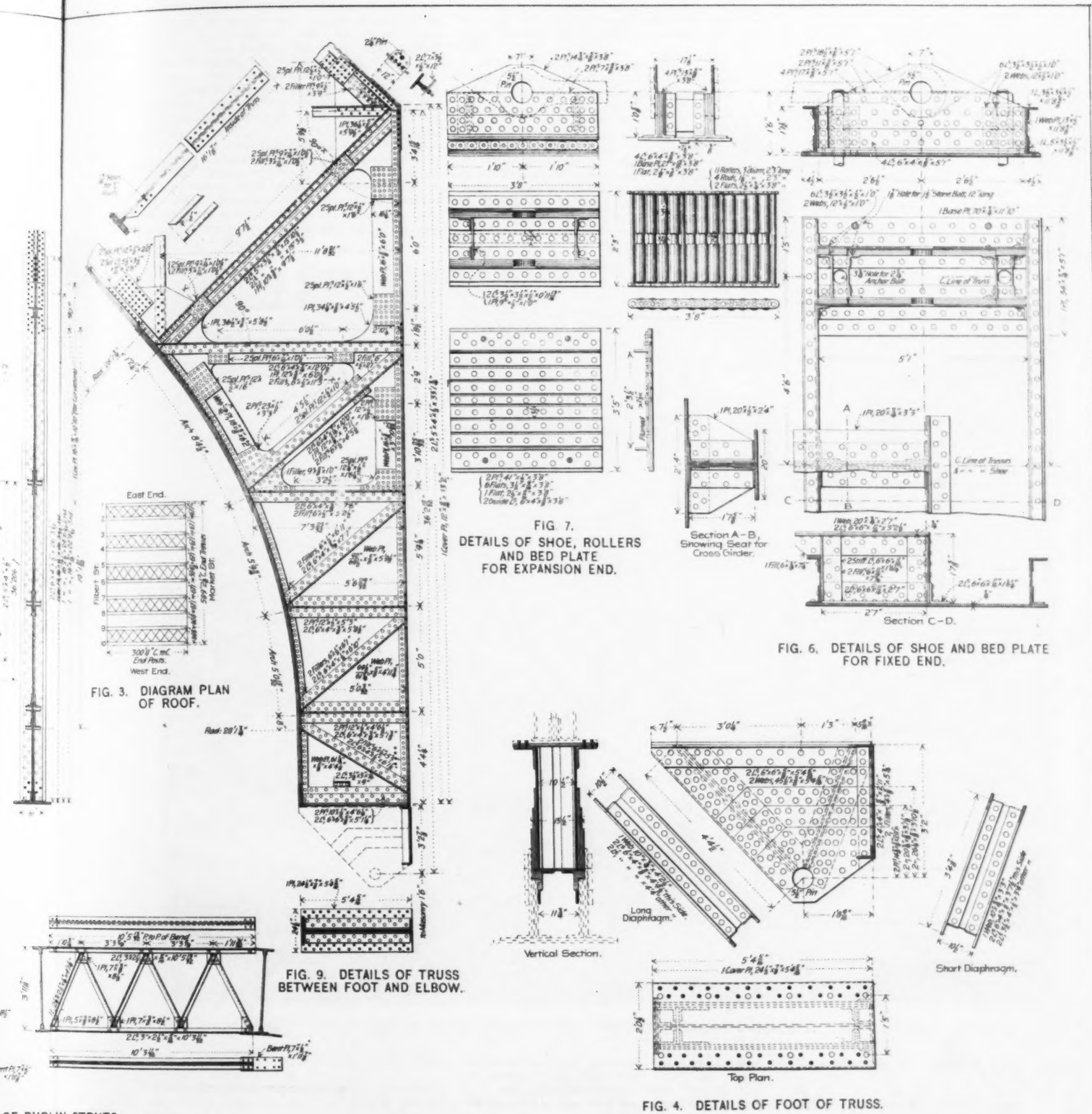


FIG. 3. DIAGRAM PLAN OF ROOF.

FIG. 7.
DETAILS OF SHOE, ROLLERS AND BED PLATE FOR EXPANSION END.

FIG. 6. DETAILS OF SHOE AND BED PLATE FOR FIXED END.

FIG. 9. DETAILS OF TRUSS BETWEEN FOOT AND ELBOW.

FIG. 4. DETAILS OF FOOT OF TRUSS.

OF PURLIN STRUTS.

HED OF THE PENNSYLVANIA R. R.; PHILADELPHIA, PA.

tt, Engineer of Bridges, Pennsylvania R. R. Co., Designing Engineers.

e & Construction Co., Contractors.

CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.

there was no lock in the canal; hence, it takes but 3 hours 11 minutes longer to pass the St. Mary's Canal than it would if there was no lock in it. Of this delay 40 minutes are occupied in making the locking, the remaining 2 hours 31 minutes being spent by boats waiting their turn to be locked. When the duplicate lock is completed, this part of the delay will be considerably reduced. A portion of this time is utilized by vessels in taking on fresh provisions, etc. If there were six locks in the Nicaragua Canal the delay would be about as follows: Waiting for turn to lock at first and third locks, 2 hours 31 minutes each; six lockages, 40 minutes each; total, 9 hours 2 minutes. It is probable that piers and lighters will be so arranged that vessels of long voyage could utilize the greater portion of this delay. Nine hours' delay in a long voyage becomes insignificant, and the actual value to commerce of the canal is practically the same with or without locks.

of business the canal may have to do a duplicate system of locks will be immediately necessary so as to make repairs possible without absolute stoppage of canal, and because vessels will arrive in fleets with favorable winds and temporarily clog the locks.

THE BROAD ST. STATION TRAINSHED; PENNSYLVANIA R. R., PHILADELPHIA.

(With Inset.)

The improvements being made to the Broad St. station of the Pennsylvania R. R. in Philadelphia, Pa., to accommodate the largely increased business of the company will make it one of the largest railway passenger stations in the world. In our issues of Oct. 6 and 13, 1892, we illustrated and described at length the general scheme of these proposed improvements, and in the accompanying cuts and on our inset sheet this week we illustrate the

pare as follows with those of the other large trainsheds of similar construction the nearest approaching it in size.

	P. R. R., Jersey City.	P. R. R., Philadelphia.	P. & R. R., Philadelphia.	Mid. Ry., London, England.
	Ft. ins.	Ft. ins.	Ft. ins.	Ft. ins.
Span of roof trusses, c. to c., end pins.	252 8	300 8	259 0	240 0
Clear height at center.	86 0	100 4	88 0	100 0
Width, out to out.	256 0	304 0	266 0	... 0
Length, " "	652 6	598 0	506 8	600 0
No. pairs of roof trusses.	12 0	10 0	11 0	... 0
No. of tracks.	12 0	16 0	13 0	*10 0

* Including 25 ft. roadway.

The span of the main roof arches for the Manufactures Building for the World's Columbian Exposition is 368 ft. c. to c. of end pins and that of the arches for Machinery Hall for the Paris Exposition was 364 ft. 2 ins. c. to c. of end pins. For complete illustrations of the Pennsylvania R. R trainshed at Jersey City and the Philadelphia &

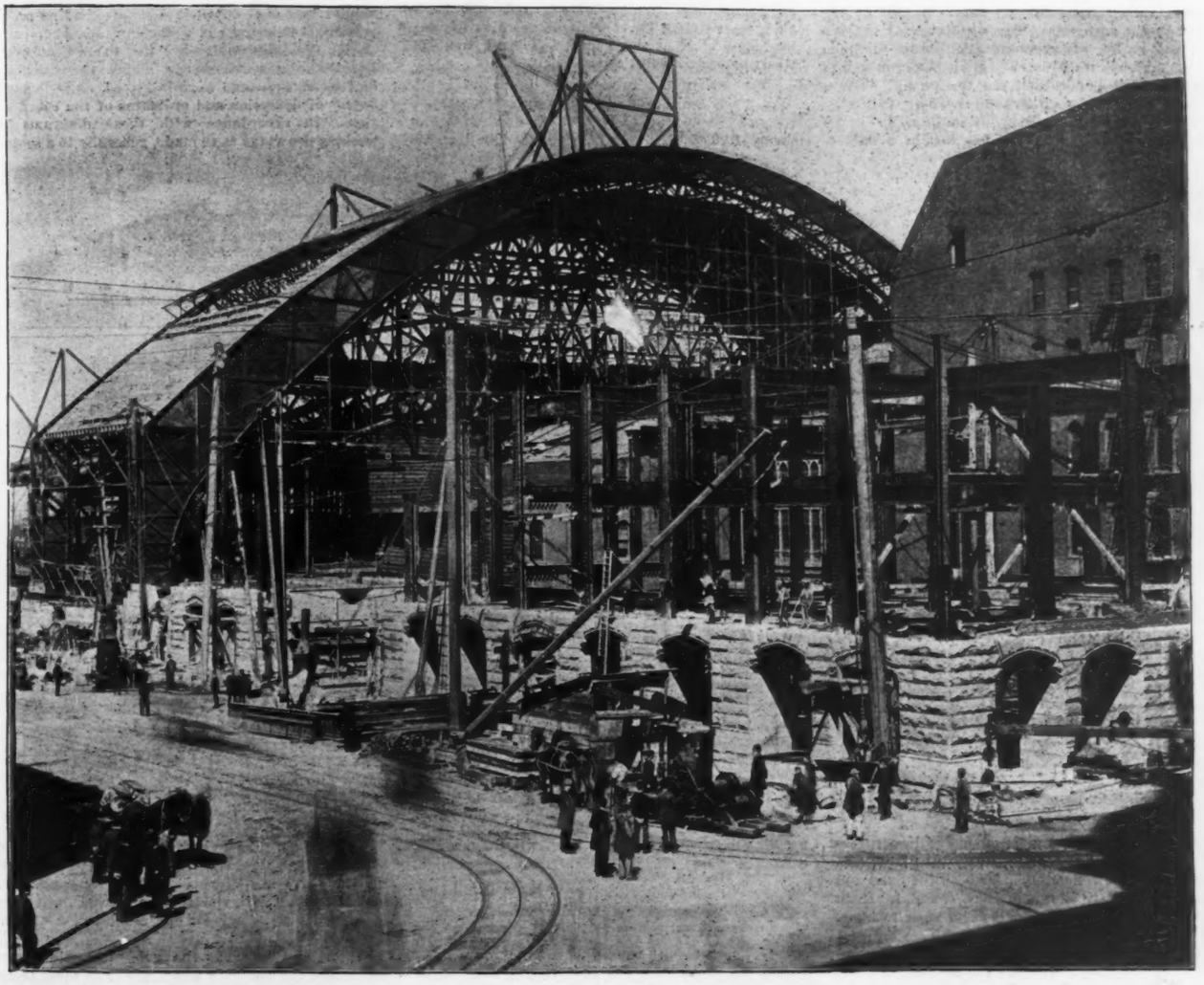


FIG. 8. VIEW OF BROAD STREET STATION TRAINSHED SHOWING ERECTION OF IRONWORK.

The conclusions which have been reached may be summarized as follows:

First.—The usefulness and value of the canal to commerce is practically the same with or without locks.

Second.—The cost of the necessary locks in the Nicaragua Canal would be about 6% of the total cost.

Third.—The cost of the locks alone, when the total lift is 110 ft., is least when the lift is 55 ft. in each lock, and therefore two locks in a set. It increases very slowly with the number of locks; three locks in a set with a lift of 36.7 ft. each, costing but $30,000 more than two locks in a set.

Fourth.—The certainty that whatever the amount

details of the large trainshed, which is probably the most interesting part of the work from a structural engineering standpoint. Aside from the Machinery Hall at the Paris Exposition in 1889, and the Manufactures Buliding for the World's Columbian Exposition at Chicago, no larger span three hinged roof arches have ever been constructed than are now being erected for this trainshed.

General Description.—Briefly stated, the Broad St. station trainshed will be 598 ft. long out to out, and 304 ft. wide out to out, and replaces a trainshed built about 11 years ago, consisting of four roof spans, two of 47 ft. each, one of 87 ft. and one of 85 ft., or 266 ft. wide c. to c. of side walls and 396 ft. 8 ins. long. Its main dimensions com-

Reading trainshed at Philadelphia, see Eng. News, Sept. 26 and Oct. 3, 1891, and Jan. 19 and Feb. 2, 1893. The Manufactures Building was described and illustrated in our issue of Sept. 1, 1892.

Arches.—The whole weight of the roof of the trainshed is supported by 10 main roof arches of wrought iron with riveted joints, each having a span of 300 ft. 8 ins. c. to c. of end pins and a rise of 108.49 ft. c. to c. of pins. Each arch is formed of a pair of parallel trusses placed 9 ft. apart c. to c. and braced together at the panel points. Details of this bracing are shown in Figs. 1 and 2. The arches are placed 67 ft. 1 in. apart c. to c., except arches Nos. 5 and 6, which are 56 ft. 4⅛ ins. apart, and arches Nos. 8, 9 and 10, which are 60 ft. 8

ins. apart c. to c. (Fig. 3). Between each pair of arches are two light intermediate trusses, which are supported from the main arches by purlins 4 ft. deep running horizontally the entire length of the trainshed through every panel point above the elbows of the arches. Below the elbows the arches are connected by two horizontal trusses.

Wind Bracing.—Arches Nos. 1 and 2, 3 and 4, 5 and 6, 7 and 8 and 9 and 10 are also connected by a system of lateral wind bracing. The structure is also further strengthened against the action of the wind by a horizontal wind truss suspended from each end arch by vertical trusses at each panel point. These vertical trusses with their horizontal bracing and the horizontal wind trusses form the ironwork of the gables.

Arch Trusses.—The main arches, as before mentioned, are each composed of two parallel, three-hinged, arched trusses firmly braced together at the panel points. The top chord of each truss, composing one-half of the arch, is built up of plates and angles with riveted joints, and is hinged at the apex and at each foot. The bottom chord consists of two $5 \times 1\frac{1}{4}$ ins. eyebars connecting the pins at the feet of the truss. These eyebars run across the trainshed underneath the tracks and sustain a maximum strain of 242,000 lbs., or 121 tons, under the assumed conditions of loading. The hinge pins are of forged iron and $5\frac{1}{2}$ ins. in diameter.

must also vary. A half elevation of one of the purlins between arches Nos. 5 and 6 is shown in Fig. 11, and elevations of two of the purlin struts forming a part of one of the intermediate trusses in Fig. 12. These drawings show clearly the composition and dimensions of the various members.

Calculation of Strains.—In calculating the strains in the main arch trusses the following loads were assumed:

Trusses above elbows, 9.5 lbs. per sq. ft. of ground plan.
Laterals and purlins, 7.5 lbs. per sq. ft. of ground plan.
Ventilator and skylight framing, 9.5 lbs. per sq. ft. of ground plan.
Total weight of one haunch, 21,000 lbs.
Covering and skylights, 15 lbs. per sq. ft. of surface.
Snow, 17 lbs. per sq. ft. of ground plan.
Wind, 35 lbs. per sq. ft. of elevation, and of plane at 80° to the horizon.

Nine different cases of loading were assumed, viz., dead load all over; snow all over; snow on 21 middle panels only; snow on loaded side and on unloaded side, separately; wind horizontal and 10° above horizontal, on loaded side and on unloaded side, separately. The permissible strains for dead load and wind or dead load and snow combined were: tension, 15,000; compression,

$$1 + \frac{\frac{15{,}000}{l^2}}{15{,}000\, r^2};$$

shear, 10,000 lbs., and bearing, 20,000 lbs. The

ficult problems. One of the most important of these is, the preparation of complete and accurate working drawings, to enable the bridge shop to construct the various parts composing the structure, so that they will properly fit together, without the necessity of laying out the arches full size on the floor of the templet shop.

The designs of the arches and other parts of the structure were made to conform, as near as possible, to the theoretical requirements to have the center lines of all the members around a panel point coincide in one point, which also simplified the working drawings. The center lines of the web members intersect each other in the pitch line of rivets in the flange angles of the chords, which is also approximately the center of gravity of the chord section; and, for convenience in construction, a rivet was always placed at this point of intersection. By this method the whole structure of the arch, as far as the shop construction and laying out of the templets were concerned, could be treated similar to a pin-connected structure, having precise points of intersection. Skeleton diagrams were made, the lines indicating the theoretical center lines of the members, in which the calculated lengths of the same were inscribed, as well as the angles of deflection and ordinates of the chord sections. In accordance with these diagrams the working drawings were made, generally to a scale of

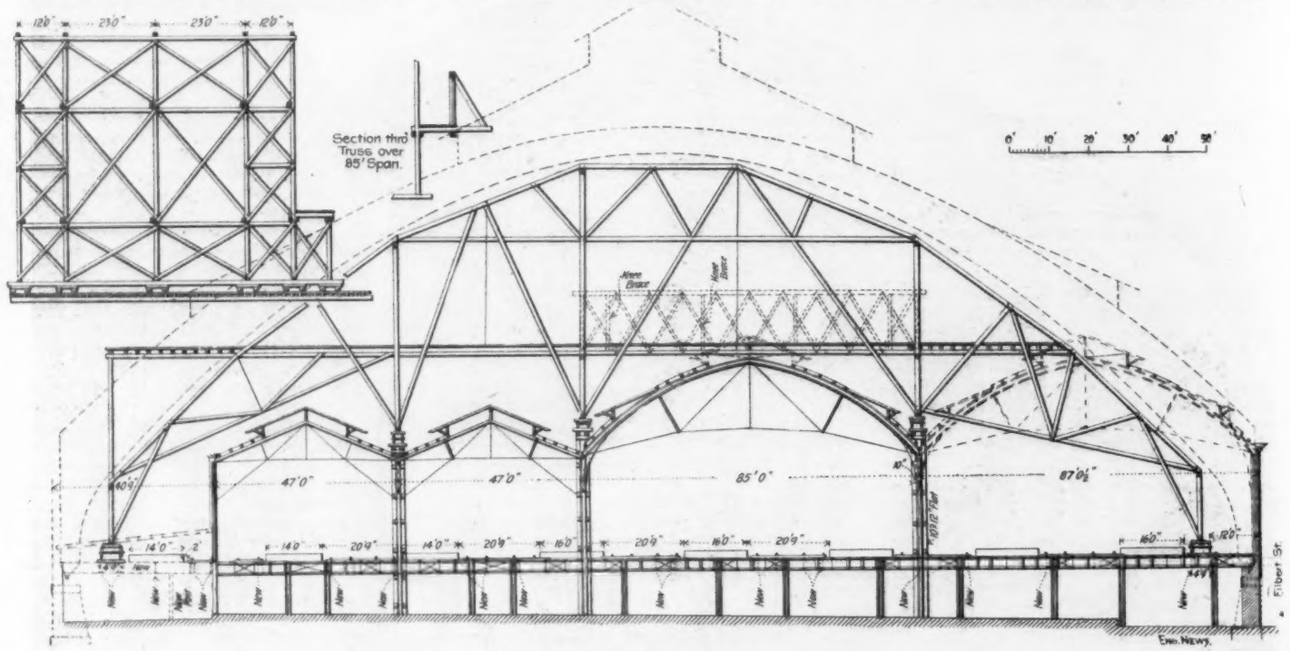


FIG. 14. ELEVATION OF TRAVELER FOR ERECTING BROAD STREET STATION TRAINSHED.

Details of the foot and apex of one of the trusses are shown in Figs. 4 and 5, and details of the shoes, bedplates, rollers, etc., for both the fixed and expansion ends are shown in Figs. 6 and 7. Each truss is divided into 18 panels from shoe to apex. The first three panels of each truss above the foot are filled by web plates, the webs of ¼ in. iron being introduced simply to close the opening and not being essential to the stability of the trusses. Above these panels the truss is a framed girder. The two end trusses are plate girders throughout, as shown in the general view of the station, Fig. 8.

Each truss is divided into 10 sections for convenience in erection, the members of each section being riveted in the shops. The section between the foot and elbow of the arch is shown in Fig. 9. These sections are, of course, joined together in the field. The joints are ordinary butt joints connected by splice plates and angles, as shown in Fig. 10. This particular joint shows the connection between sections Nos. 3 and 4.

Purlins and Purlin struts.—The purlins and intermediate trusses between each pair of main arches are simple in construction. Since the space between the arches varies, the lengths of the purlins and the spacing of the intermediate trusses

permissible strains for dead load, wind and snow: combined were: tension, 20,000 lbs.; compression,

$$1 + \frac{\frac{20{,}000}{l^2}}{10{,}000\, r^2};$$

shear, 13,500 lbs.; and bearing, 27,000 lbs. At first glance it would seem that strains of 15,000 lbs. per sq. in. for dead load and snow, or dead load and wind, combined, and 20,000 lbs. per sq. in. for dead load wind and snow, combined, were excessive for wrought iron, but an examination of the conditions will show that the probabilities of the several factors coinciding to produce the maximum are almost infinitesimally small. The strains in the different members of the truss are shown in the diagram, Fig. 13.

Specifications.—The trainshed is built throughout of wrought iron except the lower chord bars which are of acid open-hearth steel. The specifications for quality and workmanship were the same as the standard specification of the Pennsylvania R. R. for the material and wormanship of wrought iron bridges.

Shop Construction.—The shop construction of a structure of the magnitude of the trainshed involves some very interesting and dif-

¾ in. to 1 ft. Each drawing contained a section of the arch, embracing generally four panels, with all the necessary dimensions, rivet spacing, etc., and also a bill of material enumerating each piece of material necessary for the construction of that section.

From these drawings the wooden templets were made, and the ironwork was made from these templets. The chord angles were bent cold in a hydraulic press to conform to their respective curvatures. The various pieces of iron composing the members of the arches were marked off by templets, and the rivet holes punched, and the pieces cut off to accurate length and bevel; the web plates for the chord sections being planed to correct angles. After this the pieces were assembled and temporarily bolted together, riveted up in convenient sections ready for shipment, and properly marked with letters and numbers indicating the position they were to occupy in the finished structure. All shop rivets were driven by power. The whole work was done with such accuracy that no reaming or distortion of rivet holes by drifting was required during erection.

Erection.—The erection of the new station and trainshed entails unusual care and caution, since it must be done without interfering with the

handling of the present heavy traffic. As the roof is built outside and above the present trainshed, the most advantageous method of erection is obviously to construct a traveler similar to those used in erecting the Pennsylvania R. R. trainshed in Jersey City, N. J., (Eng. News, Dec. 27, 1890), and the Philadelphia & Reading Terminal R. R. trainshed in Philadelphia, Pa. (Eng. News, Feb. 2, 1893), on the top of the present station. The general design and construction of this traveler is shown in Fig. 14. It is simply a falsework center, the upper surface of which corresponds approximately in shape to the intrados of the roof arches. This center is carried on five rows of freight car trucks, two of which, at the ends, run on tracks on the trainshed floor and three on tracks directly over the columns supporting the old trainshed roof. As will be seen from the illustration, this arrangement necessitates the destruction of the 87-ft. span of the old trainshed and also the removal of the skylight roof and the shed on the south side of the station, but otherwise the old trainshed is left intact. It will be noticed that a lattice truss connects the vertical supports and extends across the 85-ft. span. The primary object of this truss is to support the landing floor over this span where no intermediate supports are obtainable. It also acts incidentally as a stiffening truss, although it is not necessary for this purpose. A series of derricks is used to convey the ironwork from the railway cars to the top of the traveler.

The ironwork is erected in sections of such size as can be conveniently shipped and erected. Each truss of one of the main arches is divided into five sections from foot to apex, or ten sections in all. The cross frames and purlins between the trusses of each arch are riveted together at the shops, leaving only the connections of the several truss sections and the connections of the cross frames and purlins to the trusses to be riveted in the field. The main purlins and purlin struts, or intermediate trusses, are erected in a similar manner.

The trainshed was designed by the engineering staff of the Pennsylvania R. R. Co., Mr. Wm. H. Brown, M. Am. Soc. C. E., Chief Engineer, and Mr. Wm. A. Pratt, Engineer of Bridges and Structural Ironwork. The structural details were worked out by the Pencoyd Bridge & Construction Co., Philadelphia, and Pencoyd, Pa., who have the contract for the work. The station is being erected by the Pennsylvania R. R. Co., the work of construction in the field, including the foundations and the erection of the ironwork, being in charge of Mr. Wm. Ziegler, Engineer of Construction. We are indebted to Mr. Brown for the matter from which our illustrations have been prepared, and to the Pencoyd Bridge & Construction Co. for the details of the shop work.

WORLD'S COLUMBIAN EXPOSITION.—XII.

Accident to Steam Pipe.

Soon after the opening of the Exposition a serious accident occurred in the Machinery Building, from the blowing-out of the blind flange of the west end of the header of the 16-in. steam pipe supplying steam for the exhibits. Three men who were under the floor were badly scalded, and one of them died from the effects of his injuries. The "American Machinist" describes the accident as follows:

The flange was what is known as an extra heavy (stock) flange, calculated for 200 lbs. steam pressure. Its outside diameter was 24 ins., and its central portion was 1 in. thick, while the faced part was 1¼ ins. thick, the whole being reinforced by stout radial ribs. The flange was bolted to a 16×16×6 ins. extra heavy tee by 20 bolts ⅞-in. diameter. The break was peculiar. The entire central part of the flange blew out, leaving the faced, annular portion undisturbed. As the pressure in the header was less than 125 lbs. at the time, it is improbable that the steady pressure made the break, especially as no flaws of any sort could be found in the casting. It is generally supposed that a water-ram caused the trouble. Yet the header was drained carefully, and the pressure had been upon it for some time. To effectually prevent another such accident, the "extra heavy" flanges will be replaced with others of very liberal dimensions. Further, instead of the cast-iron fittings along the line of the header being merely tapped by small pipes for draining, they will be replaced by others with water pockets of 8 ins. diameter, from which the accumulating water will be carefully drained.

Exhibit of the Pennsylvania R. R.

Besides its exhibits in the Transportation Building, the Pennsylvania R. R. has a building of its own, 140 ft. long, at the side of the Transportation Building, in which is an interesting exhibit representative of the progress of the Pennsylvania R. R. from the first inception of one of its component parts in 1815, when the first charter was granted to a railway company in America to construct a road from Trenton to New Brunswick, N. J., down to the present time, when it controls nearly 10,000 miles of road penetrating 13 states, and with termini in New York harbor, at Washington, D. C., in three great cities of the Ohio valley, and at five of the large lake ports.

The rear of the building represents, with its attendant features, a model Pennsylvania R. R. station of the present day, with signal tower (containing a Westinghouse electro-pneumatic machine), 100 ft. of track laid with 100-lb. rails (Eng. News, July 21, 1892), ballasted with stone, and having switches, frogs, signals, overhead foot-bridge, fences and gates. The tracks are indicative of the marked development in the last 60 years, the exhibit showing, in juxtaposition with a specimen of the standard Pennsylvania rail of 1892, a piece of the Camden & Amboy rail of 1831, with granite blocks, 2 ft. square instead of cross-ties; each block had two holes, except these at the rail joints, which had four holes. In these holes were driven locust wood plugs and the rails were fastened down by spikes driven into the locust plugs. There are also specimens of the rail used on the old Portage road over the Alleghenies, and of the very crude wood and iron rail with which the Madison & Indianapolis road was originally laid. While the Camden & Amboy rail weighed only 35 lbs. per yd., the standard rail, of which the examples shown are 100 ft. in length, weigh 100 lbs. per yd.

Upon the tracks is another contrast even more marked. One of the most interesting objects in the display is the original "John Bull" engine and its train, which here rest after their journey across the continent from New York (Eng. News, April 27). The old engine, which is one of the oldest in America, was constructed by George Stephenson, in England, and brought to this country in 1831 for use on the Camden & Amboy railway, now the Amboy Division of the Pennsylvania R. R. It stands to-day precisely as it was in 1836, after having had added to it such improvements as were then suggested to the minds of the American engineers. Its weight, with its somewhat cumbersome tender, is only 32,100 lbs., as against 200,000 lbs., the weight of the ordinary standard passenger locomotive of to-day, and beside the modern machine, of course, it looks very much like a toy. The old passenger cars, glistening with a fresh coat of green paint, are so low that a tall man cannot stand upright within them; their brakes are worked by means of handles similar to those on the horse-cars of the present time, and the only method of lighting them is by a tallow dip in each end of each car. Side by side with this tiny passenger train, is the car on which the heavy Krupp guns were hauled from Baltimore to the Exposition (Eng. News, April 20), the manner in which the guns were carried being shown by means of full-size models, made of staff, of the standard 16-in. and 10-in. guns, such as are now used by the U. S. War Department.

This policy of contrast is carried throughout the entire display, and the interior of the building, with its relief maps, charts, models, lay figures, photographs and relics, gives an excellent idea of the wonderful growth of the great Pennsylvania R. R. system. The walls of the main hall, into which the visitor may enter from either the front or the rear, are lined with handsome mahogany showcases, while the columns, so arranged as to form a colonnade on each side, are surrounded by folding frames for the display of thousands of exhibits that can be shown to advantage in this way. The labeling of the objects with a descriptive label in five languages is specially noteworthy.

In the center of the building, under the dome, upon a platform, are three relief maps, illustrating the changes in the methods of crossing the Alleghenies from the year 1832 to the present time. One of these, the largest of the three, which is 12 ft. long by 4 ft. wide, and which shows the old Portage and the new Portage roads, together with the present line of the Pennsylvania R. R., including the horseshoe curve, Allegrippus, and the district of the Johnstown flood, is said to be specially valuable as being the first and only relief map ever made of that section. The original map from which the basis of the present work was obtained, was one which belonged to the late Mr. J. N. DuBarry, Vice-President of the company. It was in lead pencil, never having been filled in in ink, and was traced, so it is said, by President J. Edgar Thomson himself. The other two relief maps show the horseshoe curve and Plane No. 1, with canalboat, cars and locomotives.

The rest of the floor space between the colonnades is dotted with pedestals and platforms, upon which are models relating particularly to the developed system of transportation of to-day. On one side, for instance, is a reproduction in miniature of the double-decked ferry boat "Washington," one of the fleet plying across the Hudson River, between Jersey City and New York. The method of handling freight cars in New York harbor is shown here in the same way by means of models of a tug boat and float. Toward the other end of the building are lay figures in uniform of the several classes of employees of the company. An object of considerable interest is a map, 33 ft. long, showing the position of each train on the Pennsylvania R. R. system at 6 a. m., Oct. 21, 1892.

With regard to the arrangement of the exhibits in the cases, and the swinging frames, considerable care has been exercised to carry out the fundamental ideas of grouping and contrast. One corner has, therefore, been given up to those features which have especially to do with motive power, another is devoted to engineering and maintenance of way, a third relates particularly to the relief department of the company, and in the remaining quarter of the spacious room are general relics, including a number of specimens of articles in use as far back as 1830 or 1831, old signals, wooden engine and car wheels, strap rails, and primitive switches and crossings. A Bureau of Information is maintained in the building, and employees are placed in charge, who will not only answer questions concerning the exhibits, but will give information relative to train schedules in current use, and other matters of interest to the traveler.

Complete as is this part of the exhibit of the Pennsylvania R. R. Co., it is lacking in one or two essentials, which are included, however, in the Transportation Building. There the company has deemed best to exhibit its finished products of 1892, in the shape of cars, turned out at its own Altoona shops, and accordingly shows three specimens of excellent workmanship: A standard passenger car, a standard refrigerator car, in which dairy products are transported; a standard track-inspection car, and a track-indicator car, which shows graphically the condition of the track, such as is used annually by the company's officers in making a tour of the lines prior to awarding prizes for the best pieces of roadbed and track, etc. The exhibit reflects credit upon the company and upon Mr. Theodore N. Ely, Chief of Motive Power, who conceived the general scheme, and also upon Mr. J. Elfreth Watkins, who, with years of service as a civil engineer in the employ of the company, and a subsequent experience of seven years as curator of the transportation section of the Smithsonian Institution, has largely aided in the execution and arrangement of the exhibit.

ELECTRIC SIGNALS ON THE BRISTOL INCLINE RAILWAY.

The Clifton Rocks Railway, 500 ft. long with a grade of 45.83%, at Bristol, England, was described in our issue of March 30, and the system of signaling adopted is described by the London "Electrical Engineer." The lower car may have any number of passengers up to 18, and a like number or fewer may be in the upper car. If there are more passengers wishing to descend than to ascend the difference in load may be sufficient to haul up the lower car, but if the weight on each car be equal or nearly so, then water is admitted into a tank on the upper car till it overbalances the lower one and it begins to descend, hauling up the other car. In order that the engineman at the top shall know the load (extra to his passengers) that is required to overbalance the lower car, it is neces-

sary for him to know the number of passengers coming up. This is accomplished by contact arrangement by which the conductor signals up, as the car fills, the number of passengers entering. These signals are received one after another upon a signal-board on each side of the engineman, an electric bell ringing at each fresh indication of additional passengers. When the car is ready to start, the conductor signals accordingly, by means of a special contact, which signal is likewise received upon the board. The engineman knows by a gage on the upper car when enough water has been admitted into the tank to take the car down, and when he is ready he sends a signal down which rings an electric bell and notifies that he is about to start the car. A local buzzer is inserted in the circuit, by the sound of which it is known that the distant bell is ringing, and the indicators are reset in the act of transmitting the "starting" signal, so that the apparatus is in perfect readiness for the next journey. Separate electrical contact and indicator boards are provided for each of the two sets of cars, and a double set of batteries to insure the proper working of the whole system, and to obviate all risk of a breakdown. Immediately a car reaches the lower end of the tunnel the water in its tank is automatically discharged into a large reservoir; this water as it accumulates is pumped up to the top, and its varying height is known at the bottom by means of an electric water-level indicator, which shows on a dial differences of 3 ins. of level either way.

PERSONALS.

Mr. Wellington Smith, a contractor for artesian wells, died at San Antonio, Tex., May 17.

Mr. Charles F. Dow, of the engineering department of the Brooklyn City R. R., died at Brooklyn, N. Y., recently.

Mr. Wm. H. Plant, formerly Roadmaster of the Rochester Division of the New York Central R. R., and later Street Superintendent at Rochester, N. Y., died at Rochester, May 18.

Mr. Geo. Hill, Consulting Engineer, New York, has been retained by Mr. John Pitcairn to design the isolated plants for electric lighting, water supply and sewage disposal for his country home.

Mr. J. C. Rawn, Manager and Engineer of the Roanoke Gas & Water Co., has been elected President of the American Bridge & Iron Works, of Roanoke, Va., vice Mr. Samuel Walton, resigned. Mr. C. C. Wentworth has been re-elected as Chief Engineer and General Manager.

Mr. L. H. Waugh, foreman of the San Antonio & Aransas Pass R. R. shops, at Yoakum, Tex., has been appointed Superintendent of Motive Power and Machinery of that road, vice Mr G. A. Hancock, resigned to accept a similar position on the Gulf, Colorado & Santa Fe R. R.

Mr. James Neilson, President of the Youngstown Bridge Co. and Vice-President of the Andrews Bros. Co. furnaces and rolling mills, died at Youngstown, O., May 25. Mr. Neilson was well known in the iron trade throughout the Northwest. He came to this country from Scotland 27 years ago, and, beginning as a clerk in the coal and iron industries, he, by industry and business ability won for himself a place in the front ranks.

Mr. Kenneth Allen, M. Am. Soc. C. E., has received the appointment of Engineer of Sewers of Yonkers, N. Y., at a salary of $2,400 per annum, the result of the "Want" advertisement in Engineering News, signed "Commissioner." Mr. Allen has had nearly 15 years' experience on various kinds of engineering work, paying particular attention to municipal and hydraulic work. He has been engaged on the water supply works and investigations at Boston and Philadelphia, designed water-works and investigated supplies for a number of small towns, and has had considerable experience in sewer work, having been superintendent of sewer construction at Kansas City, Mo. Mr. S. L. Cooper is Commissioner of Public Works of Yonkers.

NEW PUBLICATIONS.

LIFE AND TIMES OF A CIVIL ENGINEER. By James M. Searles; Supplemented by the True Theory of the Mississippi River. Cincinnati, O.: Robert Clarke & Co. 12mo; paper; 139 pp.

The author of this book was a Southern man, and his reminiscences of engineering experiences are chiefly connected with the South and West. He served throughout the Civil War in a Louisiana regiment, and saw very much service. His trials, tribulations, and disappointments as a civil engineer, both before and after the war, are told in a somewhat disjointed, but effective, manner, and the conclusion that the author ultimately arrives at, from his own experience, is that the civil engineers who really do the hard work are the poorest paid, and that "money and influential circumstances, uncoupled with true merit, push so many up the ladder, that the worthy one can only look up." Though, thus evidently, a man who has not realized his hopes as to professional advancement, Mr. Searles is still in active practice, and is now locating a railway in Guatemala, according to his preface. The True Theory of the Mississippi River is that of Mr. Charles Ellet, and Mr. Searles makes copious extracts from it to call renewed attention to what he also deems is the best and most economical solution of the problem.

A STANDARD DICTIONARY OF THE ENGLISH LANGUAGE.—New York: Funk & Wagnalls. $12.

A broad and complete dictionary of the English language, covering the wide range of technical terms which were omitted from the old "unabridged" dictionaries, is one of the most valuable aids to the work of every professional man. That such a complete work is soon to be made available at a moderate price will be good news to thousands who have been unable to afford the costly volumes of the "Century" dictionary. The Standard dictionary, according to the prospectus, is to contain over 2,200 pages, and a discount of one-third from the list price is offered to advance subscribers. Among the staff of editors on special subjects, we notice the names of Hon. T. M. Cooley, Constitutional Law; Hon. E. J. Phelps, International Law; Carroll D. Wright, Statistics; Geo. F. Kunz, Gems; Geo. P. Merrill, Building Stones; Ralph W. Pope, Electricity; Prof. N. S. Shaler, Geology; T. M. Prudden, Bacteriology; Dr. Simon Newcomb, Astronomy, Mathematics and Physics.

PROCEEDINGS OF THE FIFTH ANNUAL CONVENTION OF RAILROAD COMMISSIONERS. Pub. Doc., 1893. 8vo; paper; pp. 103.

This pamphlet contains in full the proceedings at the annual convention of railroad commissioners from the several states. An abstract of these proceedings was given in our issue of May 4, 1893, and little more needs to be said.

DIFFERENCES OF ALTITUDE.—Table for Obtaining for Any Even Minute up to 15 Degrees, and for Any Distance. By Arthur P. Davis, C. E., Los Angeles, Cal. Large; 8vo; muslin; 16 pp. of tables. $1.50.

This is purely a book of tables for finding the differences of altitude when the angle of elevation or depression and the horizontal distance are known. Corrections for curvature, refraction and height of instrument, the latter taken at 4.5 ft., are included. The tables are very plainly printed, and the operation of obtaining the differences in altitude is little more than one of inspection. It was especially designed and computed by Mr. Davis for plane-table map work, though it can, of course, be used with transit or other work, and it should commend itself to engineers as a labor-saving device.

VENTILATION AND HEATING. By John S. Billings, A. M., M.D., LL.D., Edin. and Harvard, D. C. L. Oxon., Member of the National Academy of Sciences, Surgeon U. S. Army, etc. New York: The Engineering Record. 8vo; cloth; pp. 500; 210 cuts; $6.00.

While the volume before us includes the matter contained in Dr Billings' book on "The Principles of Ventilation and Heating," published in 1889, a great deal of new matter has been added, and it is substantially a new work. The first thing which strikes the engineer who turns over its pages is that it is a good deal of a treatise on ventilation and very little of a treatise on heating. Of the 20 chapters in the book, we find only one devoted to heating alone, while 16 are devoted to ventilation, and the remaining four discuss heating and ventilating together. Necessarily, therefore, the author's discussion of heating appliances and methods is very brief and unsatisfactory. In fact, it would have been better to have called the book "A Treatise on Ventilation," as the matter on heating is not more extended than is really needed to complete the author's discussion of his main subject.

As a treatise on ventilation, the book certainly deserves hearty praise. The author writes, indeed, from the standpoint of the doctor rather than that of the engineer, and to this is due, perhaps, his tendency to neglect the question of comparative cost and to insist on very high standards. The problem oftenest presented to the engineer is how to get best results with a limited amount of money.

In the chapter on moisture of the air and its relation to ventilation, Dr. Billings contradicts the common fallacy that dry air is injurious to health. This chapter is one which deserves careful study by everyone engaged in the manufacture or installation of heating apparatus; for there are few topics in connection with heating and ventilation on which erroneous opinions are so widespread.

The matter in which the book seems to deserve most criticism is in the small importance which the author gives to power-driven blowers in heating and ventilating. The time is coming when all the methods of ventilation which depend on heating the air to induce it to move will be condemned for their wastefulness. The work could be done with a small fraction of the heat if it were converted into power. For example, take the use of small ventilating flues in which a gas jet is kept burning to produce a draft. The same gas burned in a gas engine would give power enough to ventilate a whole house five times over. It may be said that this is not practically possible at present, but it is rapidly being made practically possible, and is destined not only to supersede the old and wasteful methods of ventilation, but to reduce the cost of ventilation, so that a far greater number of people can afford to breathe pure air.

For the question of ventilation is in a very large degree a question of dollars and cents. Heat is a necessity; but pure air, according to common standards, is a luxury. The use of the blower in combination with coils heated by exhaust steam has made good heating and ventilating of mills and shops so cheap that many factory buildings nowadays are heated and ventilated far better than many a rich man's house.

We do not mean to say that the author overlooks the question of cost, nor that he ignores the blower system as a factor in ventilation. He makes more or less reference to the economic factor continually, and he describes many excellent plants in which blowers are used. But there is no positive and broad recognition of the blower as a machine which has worked and is working a real revolution in heating and ventilation.

The author's treatment of the ventilation of mines, tunnels, railway cars, ships, sewers and shops is like his discussion of heating appliances—brief and superficial. On the other hand, his chapters on carbonic acid, quantity of air required for ventilation, examination and testing of ventilation, and filtration of air, and his descriptions of existing plants, contain matter of great value to the engineer.

TRADE PUBLICATIONS.

OIL WELL SUPPLIES.—Oil Well Supply Co., Pittsburg, Pa., and New York, N. Y., 4to; cloth; pp. 374, illustrated.

This is a very handsome and complete catalogue of almost every kind of supplies used in oil and natural gas well work, ranging from engines, pumps and drilling rigs, to drills, tongs, tools, gas burners, engine supplies, etc., all fully illustrated. It commences with illustrations and descriptions of complete permanent and portable rigs, with wooden and steel derricks; and then shows sections of wells, with tubings, and the details of the various appliances, including drills, torpedoes, pipe tongs, fishing tools, sand pumps, valves, etc. The company also furnishes regulators, gas fixtures, and burners, meters, etc., for natural gas. The index covers 14 pages.

LOCOMOTIVES.—Baldwin Locomotive Works, Philadelphia, Pa., 4to; cloth; pp. 78; illustrated.

This is a very handsome description of the Baldwin Locomotive Works' exhibit at the World's Columbian Exposition, with lists of dimensions and photographic illustrations of the engines. The exhibit includes eight-wheel engines, double-ender engines (four driving wheels, and leading and trailing pony trucks), mogul, consolidation, ten-wheel, and decapod (Erie R. R. engines, and two small mill and logging engines. Some of the engines are Vauclain's four-cylinder compounds. We shall describe this exhibit fully in connection with our articles on the World's Columbian Exposition.

FROGS AND SWITCHES.—Weir Frog Co., Cincinnati, O.; 8vo; cloth; pp. 233; illustrated.

This is the latest edition of the company's handsome and comprehensive catalogue, well printed on good paper, and with excellent illustrations. In addition to numerous patterns and designs of frogs, switches and crossings, there are switchstands, steel rail braces (Eng. News, July 7, 1892), bridge guards and expansion joints, and other track details of steam and street railways.

WATER LIFTER.—Goulds Mfg. Co., Seneca Falls, N. Y. 8vo; pp. 15; illustrated.

The Duplex water lifter is operated by water pressure from city mains or other source, and will pump automatically water from cisterns or raise city water higher than its own pressure will carry it. The device has a general application for filling supply tanks in residences, office buildings, etc., and may be employed where water pressure is insufficient to carry supply to all points desired, or, where the supply is impure, for pumping other water supply from cisterns or other source. It is said to be meeting with approval from all parts of the country.

SOCIETY PROCEEDINGS.

ENGINEERING ASSOCIATION OF THE SOUTH.—At the regular monthly meeting at Nashville, Tenn., May 11, there was an excursion to points of technical interest near Nashville. In the forenoon visits were made to the extensive new shops of the Nashville, Chattanooga & St. Louis Ry., the city reservoir, and the power plant of the street railways. After dinner the party, about sixty in number, spent the afternoon in an excursion on the river, visting the city pumping station, the most recently constructed electric light

plant, the site of the lock now under construction on the Cumberland River, and the three Cumberland River bridges.

At the evening session there was a discussion on "The Durability of Yellow Pine." Mr. Hunter McDonald thought that yellow pine is not so durable now as formerly, ascribing as a reason, among others, the common practice of tapping pine for turpentine; also the fact that much of this timber comes from "old field pine," a secondary growth which has followed the clearing of the original forests. He thought erroneous the theory that tapping removes the turpentine from the sap only and not from the heart, and that the whole stick is made more porous for the absorption of moisture. Some bridge timbers of pine, not tapped, were mentioned, which were sound after 14 years' service, while nearly all pine timber now has to be renewed in five or six years. He does not now paint wooden members of bridges, but houses them, allowing free air circulation. In the Tennessee River bridge at Johnsonville are housed timbers sound after 21 years' use. He believes that if timber could be protected from the weather two years, then well painted, it would add four years to its usefulness. He finds more difficulty in judging when a stick is unsafe from decay than in protecting it, and thinks some practical tests for timber in place would be of great benefit.

Mr. W. C. Smith agreed that timber when from original forest and not tapped lasted better than otherwise, and called attention to the hastening of dry rot by confining timber in walls. The confined ends of joists have rotted in nine months when the rest was still good. In his practice, he either leaves an air space around the ends of joists or builds projecting bearings for them. Poplar lumber, sawed from river rafts, he found, decayed in two years when exposed to the weather, and at the same time lasted well on interiors. A number of other interesting facts were elicited by the discussion. (Extensive tests, conducted under the supervision of the Forestry Division, and described in our columns, show that tapping for turpentine has no weakening effect upon pine timber. Ed.)

Walter G. Kirkpatrick, Secy.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on April 19, Capt. Carl F. Palfrey read a paper on "Three Reconnaissance Maps in the Latter Part of the Last Century, as Compared with the Maps of the Mississippi River Commission." The paper was an interesting discussion of the changes in the river for the last century. The old maps, while containing some errors, were, on the whole, remarkably accurate.

At the meeting on May 3, Mr. N. W. Eayrs presented the paper of the evening on "Corroded Girders in the Bridge Approach, illustrating a Peculiar Condition of the Strains in the Webs of Plate Girders." The web in a number of the girders had been corroded and eaten away, leaving a number of large holes in the web. The girders were erected nearly twenty years ago. The destruction of the web was caused by the smoke and heat of the engines. In painting the girders a charcoal and litharge paint was found to be the best, owing to its remaining soft in spite of the heat. Prof. Johnson described a new apparatus for testing the girders in bridges.

At the meeting on May 17, Mr. Moore, President, in the chair. Mr. E. A. Hermann read a paper on "High Speeds on Railways." The ideal of high speed has risen from an average speed of 12 miles per hour on the primitive railways to 50 miles on the best railways of to-day, and now still higher speeds of 80 to 100 miles per hour are demanded. This could readily be accomplished if it were a question of motive power only. Either the steam locomotive or the electric motor could draw light trains at that speed. The comparative perfection of the motive power, however, is not equaled by that of the roadways and the facilities for preventing delays by interference from freight and other slower trains. A railway on which it would be safe to run trains at such high speeds would require four tracks to separate the fast trains from the slow ones; the cost of such a road would be so much greater than the cost of any existing road that its construction in the near future is very doubtful.

It is more practicable to aim at a sufficient improvement of the existing railways to permit the attainment of long sustained, moderately high average speeds. High speeds of 70 to 80 miles per hour are attained in regular daily service, but these speeds extend over short distances only on account of heavy grades, delays from other trains, etc. Where the railways are improved sufficiently to permit a more uniform moderately high average speed, such as could then be easily maintained, the running time between terminal stations will be greatly reduced. All the first class railways are being gradually improved, and with these improvements will come higher speeds; they will be developed gradually in the future as they have been in the past, as the gradual improvement of the roadway makes such high speeds safe and profitable.

For the next meeting a paper by Professor Howe, on "The Hinged Suspension Bridge," was announced.

Arthur Thacher, Secy.

WESTERN RAILWAY CLUB.—Owing to delay in completing the coupler tests, it has been found necessary to again postpone the May meeting of the Club, and it will be held in Room 842, Monadnock Building, on Tuesday, June 6, at 2 p. m. The subjects for consideration are M. C. B. Coupler Tests and Grab Handles on Freight Cars.

Clement F. Street, Secy.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the annual meeting in January it was decided that the Board of Direction having accepted the charge of Division "A," or the Civil Engineering Division of the International Engineering Congress, the meeting of the annual convention of the Society should be held at the same time and place. The convention will therefore be held at Chicago in the Art Palace, beginning Monday, July 31, and ending Saturday, Aug. 5, inclusive. This building is in Lake Front Park, on Michigan Ave., and faces Adams St.

There will be general sessions of the Congress, comprising all the divisions, on Monday and Saturday. The opening session will consist of very brief addresses by the officers of the Congress and probably also the heads of the Divisions, and by distinguished men and delegates from abroad. This Society will probably hold a short session of its convention afterward. There will be regular sessions of the convention, on the intervening days, beginning at ten o'clock and lasting till one. The business meeting of the Society will be held on Tuesday evening, and there will be also an adjourned business meeting on a later evening. These two evenings are required for the selection of a nominating committee, by the plan adopted by the Society at the last annual meeting. A later circular will give a list of the papers to be presented, and of dates on which they will be open for discussion. The following particulars are condensed from a circular issued by the Society:

Arrangements have been made by the executive committee of the several engineering societies of the country for a headquarters for engineers. Rooms have been taken for this purpose at No. 10 Van Buren St. (a part of the Art Institute Annex). This is two blocks south of the Art Palace, just west of Michigan Ave. In addition to this the southwest corner of the gallery of the Mines and Mining Building at the Exposition grounds has been set apart for the use of the engineering societies. To secure these privileges the secretary of this Society will furnish cards to members applying for the same, which are exchangeable at the headquarters, in Van Buren St., for cards of admission to the engineering congress and the reception-rooms. The station at the entrance of the Exposition grounds is about 20 minutes by the Illinois Central R. R. toward the south from the Art Palace. The grounds can also be reached by the elevated and cable roads, and by boat on the lake.

Owing to the fact that those members who responded to a former circular gave various dates for arriving at and leaving Chicago, and to other difficulties, the Board of Direction at its last meeting decided not to attempt to arrange for a special rain to the Convention, but to give all the information possible and let each member make his own arrangements. The trunk railway lines have fixed the following rates from New York to Chicago: For the limited train one way, $28 including sleeper, or $56 both ways. For all other fast expresses, $20 one way, or $40 for the round trip, and $5 additional each way for sleeper. For the special trains leaving New York at 8 p. m. on the Pennsylvania and 9:15 on the New York Central R. R., $32 for the round trip, and $10 for the round trip for berths. These trains are two nights and one day or about 35 hours in making the trip. Meals on any of the trains cost $1 each.

Raymond & Whitcomb, New York, will run a train leaving New York on the morning of Friday, July 28, and returning to arrive at New York, Monday, Aug. 7. For $125 they furnish first-class transportation both ways and berths in Pullman sleepers, meals on the route, transfer passenger and baggage at Chicago, entertainment at their hotel in Chicago for one week, and twelve admissions to the Fair grounds. Thomas Cook & Sons, New York, offer for $120 a similar excursion, going by way of Niagara, and spending one day at the Falls and one week at Chicago, and returning by way of Washington, spending two days there; the trip to include first-class railway fare, sleeping car and hotel accommodation, six admissions to the Fair, transfer to and from hotels, carriage drives, etc., $25 deposit required to secure a place.

In response to the circular sent out March 3, about 20 members requested rooms for the accommodation of 42 adults. After a personal visit the secretary selected the Chocago Beach Hotel, located directly on the shore of the lake, at five minutes' walk from the entrance to the Fair Grounds, and fifteen minutes from the Art Palace, as being the most desirable. It is new and fire-proof, free from the confusion of the Fair or the city, and a short distance from Hyde Park station on the Illinois Central R. R. The rates are $7 per day for two persons in a room on the European plan, or $10 on the American plan. The hotel is kept by W. F. Leland, who is well known in the business. Members can probably secure accommodations there if it be done soon.

ENGINEERS' CLUB OF PHILADELPHIA.—The regular meeting was held May 20, Vice-President F. H. Lewis in the chair; 33 members and visitors present. In answer to the question as to the rules prevailing among architects and builders for vertical pressures that can be safely borne by high masonry walls, it was informally stated by Mr. W. C. Furber that the rules which prevail among architects and builders for proportioning of high masonry walls are, to a large extent, empirical ones. These rules, under ordinary conditions, give safe results. All large cities, however, have building regulations which prescribe minimum thickness for various heights, and which are supposed to have been derived from observation and practice. There is, nevertheless, a marked difference in what each city considers sufficient. An empirical rule, which gives safe results under most circumstances, is to start at the uppermost story with walls 1½ bricks in thickness and increase each story ½ a brick descending. These figures will do for warehouses and heavy buildings, but are too large for the ordinary light buildings. Perhaps the most approved and generally accepted formula for calculating the safe thickness for high masonry walls is that given by Louis de Coppet Berg, which is a modification of Rankine's formula for long columns, and while too long for complete insertion here can be found in Berg's "Safe Building."

In opening the discussion on Loads for Ball Bearings, Mr. Wilfred Lewis explained that the question was intended to cover roller bearings as well as ball bearings, and that in view of the large and increasing demand for these bearings it was remarkable how little definite information could be obtained concerning them. Some time ago he wrote to a prominent manufacturer of ball bearings for such data as could be given in regard to the carrying capacity of hardened steel balls between plates of the same material, and in reply he was informed that almost nothing was positively known. Some crude experiments had been made upon ⅝-in. balls, which showed them to have an ultimate strength of 2,000 pounds and a safe working limit of 400 pounds, but for car journals, in which the motion was continuous and rapid, 200 pounds per ball was recommended as preferable. Whether a ¾-inch ball would carry twice as much or four times as much as a ⅝-inch ball could not be stated, but the impression seemed to be that, over a given extent of surface, more load could be carried on small balls than on large ones. The effect of hardening was believed to increase tenfold the carrying capacity of a ball bearing. In regard to roller bearings, but one formula is known to be in common use. This makes the load carried by any given roll proportional to the square root of its diameter, and the general adoption of this formula may be credited to the authority of the late C. Shaler Smith, while the investigation upon which it is based is said to be due to Prof. Grashof.

L. F. Rondinella, Secy.

COMING TECHNICAL MEETINGS.

ENGINEERS' CLUB OF PHILADELPHIA.
June 3. 1122 Girard St. Secy., L. F. Rondinella.
SWEDISH ENGINEERS' CLUB.
June 3. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.
WESTERN RAILWAY CLUB.
June 6. "M. C. B. Coupler Tests" and "Grab Handles on Freight Cars." Secy., Clement F. Street, Monadnock Building, Chicago.
ENGINEERS' CLUB OF ST. LOUIS.
June 7. Secy., Arthur Thacher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 7. Secy., F. Collingwood, 127 East 23d St., New York.
WESTERN SOCIETY OF ENGINEERS.
June 7. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
June 8. Secy., F. W. Mowbray, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTH.
June 8. Secy., W. G. Kirkpatrick, Nashville, Tenn.
MONTANA SOCIETY OF CIVIL ENGINEERS.
June 10. Secy., G. O. Foss, Helena.
ENGINEERS' CLUB OF KANSAS CITY.
June 12. Secy., Waterman Stone, Baird Building.
WISCONSIN POLYTECHNIC SOCIETY.
June 12. Secy., M. F. Schinke, City Hall.
DENVER SOCIETY OF CIVIL ENGINEERS.
June 13. Secy., F. E. King, Jacobson Block.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
June 13. Secy., Parker N. Black, Capitol Block, Atlanta, Ga.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
June 13. Secy., F. C. Osborn, Case Library Bldg.
NORTHWEST RAILROAD CLUB.
June 13. Ryan Hotel, St. Paul. Secy., W. D. Crosman.
NORTHWESTERN SOCIETY OF ENGINEERS.
June 13. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
MASTER CAR BUILDERS' ASSOCIATION.
June 13. Lakewood, N. Y. Secy., J. W. Cloud, Buffalo, N. Y.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
June 14. Wichita, Kan.
NEW ENGLAND WATER-WORKS ASSOCIATION.
June 14, 15, 16. At Worcester, Mass. Secy., R. C. P. Coggeshall, New Bedford, Mass.
NEW YORK RAILROAD CLUB.
June 15. Secy., H. G. Prout, 73 Broadway N. Y.
ENGINEERS' CLUB OF CINCINNATI.
June 15. Secy., J. F. Wilson, 24 W. 4th St.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
June 15. Secy., C. F. Franson, Portland Block.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
June 16. 201 Washington Building.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
June 16. Secy., D. W. Meeker, St. Paul.
AMERICAN RAILWAY MASTER MECHANICS ASSOCN.
June 19. Lakewood, N. Y. Secy, Angus Sinclair, New York.
COLUMBIAN ENGINEERING SOCIETY.
June 20. Secy., F. W. Hart, Washington, D. C.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
June 20. Secy., R. H. Clark, Pittsburg.
BOSTON SOCIETY OF CIVIL ENGINEERS.
June 21. Secy., S. E. Tinkham, 36 Broomfield St.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
June 23. Secy., C. H. McLeod, Montreal, P. Q.
ENGINEERS' CLUB OF MINNEAPOLIS.
July 4. Secy., E. Nexsen, 504 Kasota Block.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
July 7. Secy., E. K. Smoot, 808 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
July 7. Secy., O. Von Geldern, 719 Market St., San Francisco.
NEW ENGLAND RAILROAD CLUB.
Sept. 12. Secy. F. M. Curtis, O. C. R. R., Boston.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Sept. 5. Secy., W. Halliburton.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Sept. 20. Secy., L. V. Carmait, Roanoke, Va.
CENTRAL RAILWAY CLUB.
Sept. 27. Secy., S. W. Spear, Buffalo, N. Y.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Oct. 9. Secy., C. L. Annan, City Engineer's Office.

ENGINEERING NEWS

AND

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The Manhattan Railway Co. has officially withdrawn all propositions made by it to the New York Rapid Transit Commission, and in commenting upon this action Mr. Starin, one of the Commissioners, furnished some figures that should be of interest to the city of New York as well as to the owners of elevated railway stock. He compares the propositions made by the Commission and the Manhattan Co. as to compensation as follows. From gross earnings of the Manhattan Co., amounting to $10,835,978, in 1892, Mr. Starin deducts $5,855,213 for operating expenses and taxes; this leaves $4,980,765 for net earnings, which the Commissioners propose to tax at 5%, realizing for the city $249,038 for that year. The Manhattan Co. proposed to pay 3% on net earnings after deducting $1,919,052 interest on bonds, in addition to the operating expenses and taxes. This would have left $3,061,713 to represent net earnings, and 3% on that would only amount to $91,851. This is a difference with a broad margin, and it is little wonder that the parties to the proposed agreement could not agree. In defense of the proposed 5% tax Mr. Starin said that the average cost of operating surface street railways in New York was 72% of the gross earnings; and yet these companies are required to pay to the city for their privileges 3% annually of their gross receipts for the first five years and thereafter 5% of their gross receipts. In contrast to this the operating expenses of the Manhattan elevated system are only about 50% of gross receipts, and the Commission's proposition would only have amounted to about 2½% on this, or less than half of the tax now paid by surface railways. If taxed at the same rate, last year, as the surface roads, the Manhattan Co. would have paid to the city $541,798 in addition to $479,864 regular taxes upon real estate. The Commission's proposition amounted to $249,038, or less than half this tax for privileges alone. To put it in another form, says Mr. Starin, the tax upon the surface roads amounts to ¼ ct. for each passenger carried, while that proposed by the Commission was 1-9 ct. per passenger, and the Manhattan offered to pay 1-24 ct.

The communication of Mr. Starin to the Commission points out that the Manhattan Co. would be subjected to no exceeding hardship even if it did accede to the Commission's proposition. In 1892 that company would have earned 9.37% on its capital stock of $30,000,000, even if it had paid the tax proposed. The total of the company's stocks and bonds is $70,000,000, and Mr. Starin thinks that if these roads were capitalized at something more nearly approaching their actual cost they could have carried the 214,000,000 passengers of last year for a 3-ct. fare each, and yet have paid 6% dividends upon the actual cost of the roads. In estimating the cost of proposed extensions the Manhattan Co. has also been evidently very liberal in reaching its figures of $22,694,976. Of this sum the extension to Yonkers, virtually thrown out by both parties now, figures at $4,200,000; iron is figured at 4 cts. per lb., while a contract for 30,000 tons of a similar elevated structure has lately been let in Chicago at 3 cts. per lb., and real estate has also been estimated for at extravagant figures. Mr. Starin believes that the total cost of the extensions now proposed would be much nearer $14,000,000 than the sum named by the company. Assuming that the figures here quoted are even approximately correct, they would appear to furnish the best kind of an argument for a rapid transit system built and owned by the city. Or, given a thoroughly business-like basis to start upon and anything approaching the privileges of the present elevated system, there should be no real trouble in enlisting private capital in this enterprise. The Rapid Transit Commission has not as yet invited outside capital upon the lines suggested; and will not until the requirements of the proposed system and the standing of both parties to the proposed contract are much more clearly defined than they have been in the documents so far issued for the benefit of outside parties.

There is no disguising the fact that the attendance at the World's Columbian Exposition during its first month has been disappointing compared with what was hoped for and prophesied in the early days of the enterprise. There are numerous reasons for this. First and foremost is the unfinished state of the exhibits. It mattered not that such exhibits as were completed with the grounds and buildings made a greater display than the world has ever seen. It is human nature to want most what is not to be had, and many a visitor during the past month has gone home to denounce the Fair to his friends and neighbors because some building or some exhibit was not yet ready for his inspection. A second reason for the slim attendance has been the cold weather; a third is the general financial depression and uncertainty which is now prevalent; a fourth is the wide circulation of highly exaggerated reports as to extortion by the restaurants on the grounds and other holders of concessions; and a fifth is the fact that the railways have not yet begun to run cheap excursions to Chicago.

But with the opening of the second month of the Exposition, most of these reasons for a slim attendance will disappear. The exhibits in every department are now practically complete; in June, if in any month, bright skies and balmy air may certainly be looked for; the stories concerning extortion ought to have spent their force by this time, or their influence should be counteracted by the more truthful reports of visitors to the Fair. There remain then only the financial troubles and the lack of cheap railway fares still in operation to check the tide of visitors to Chicago. The first of these must be left to take its course, more's the pity; but the second is within the power of the railways to remedy, and the sooner they set about it the better will it be for their exchequers as well as for the Exposition. There has been much newspaper criticism of the New York and Chicago lines because they have reduced their regular rates only 20%, and that only on the slower trains. Thus the first-class fare from New York to Chicago and return via the Pennsylvania or New York Central 24-hour trains is $40. But on the slower trains over the same roads, which run through in two nights and a day and are practically just as good for the through traveler, the fare is $32. The Erie, Baltimore & Ohio, Lehigh Valley and other less direct roads have a differential; and a first-class round trip ticket costs only $28. Despite all the criticism of the newspaper press, it can be shown that these rates are low enough. In passenger traffic as in freight traffic the correct and equitable principle in adjusting rates is to charge in proportion to what the traffic will bear. It is just and equitable that the man whose time or ease are so valuable that he can afford to pay $8 extra fare in order to spend a night at home or in a hotel rather than in the berth of a sleeping car should do so. If the limited expresses over the Pennsylvania and New York Central are well patronized, it simply means that the wealthy are willing to pay an extra sum to ride in the fastest and most fashionable trains. As for the $32 and $28 charged on the slower trains and longer routes, it is to be remembered that these rates hold good for the whole duration of the Fair, and affect not only the travel to the Fair, but all other travel as well. The railways are virtually making a present, to their patrons traveling on other business, of one-fifth the price of their tickets in order to stimulate the travel to the World's Fair. It can be seen at once that a very considerable volume of World's Fair traffic must be secured to make up for the loss due to the reduced price at which the current volume of regular travel is carried.

The people who will pay their $28 or $32 for a ticket to Chicago and return are for the most part those who can afford to pay this sum. They are the business men and their families whose incomes justify their trip and whose railway fare will be a small part of their expenses. It may be fairly contended that the reduction of one-fifth which has been made is sufficient stimulus to travel of this class. A very large proportion of these people would go to Chicago anyway even if no reduction were made, and certainly a rate of 1.4 cts. per mile for a first-class ticket is not an excessive fare.

But allowing that the 20% reduction already made is sufficient inducement for this class, the fact must be faced that there is a large class of people, far outnumbering those just considered, to whom $28 is a very large sum indeed, and to whom some further reduction must be made if they are to contribute anything toward swelling this year's passenger earnings. Among this class are the "bargain hunters," to whom some such sum as "$19.57, regular price $40," advertised in flaming handbills, appeals with twice the seductive force that the $28 fare does. In other words, the fact must be faced that with the railway's management of their excursion business during the next five months the growth in this year's passenger earnings and the attendance at the World's Fair are largely dependent. In what we have written above we have used the New York-Chicago rates merely to give the figures on which rates between Chicago and the East, the principal source of visitors to the Fair, will be chiefly based. The same principle applies to the travel toward Chicago from all quarters. The great bulk of the people who can afford to pay the regular rates will not patronize the excursions because their time is so occupied that they must go when they can most conveniently and they cannot afford for the sake of a few dollars saving in fare to change their plans to go at the day and hour when a cheap excursion starts.

This is exactly what the general passenger agent desires if he wishes to stand by the spirit of the railway agreements! Every Chicago excursion which aims at further cutting the regular rates deserves to be frowned upon by those in authority; but excursions so planned as to reach the multitudes who cannot afford the full rates, and to exclude those who can afford them, should be set in motion in every possible direction at the earliest opportunity.

One way in which this end can be reached is by arranging long distance excursions to stop off over night. There is likely to be a dearth of sleeping cars this summer anyway; and a very large proportion of the travelers by cheap excursions are not accustomed to use them. The $2 which a berth in a sleeper would cost would purchase supper, lodging and breakfast in a fairly good hotel, or an even less price for a large party might be secured by the railway for a special party. Such an arrangement as this would not only satisfy the patrons of the excursion, but would prevent those whose time is more valuable and who can afford to pay the regular fare from traveling at lower rates. Moreover, this operates in effect as a reduction from the regular fare. The actual traveling expenses of the average journey from New York to Chicago and return by regular trains and by special excursions might foot up about as follows:

	Regular.	Excursion.
Round-trip ticket	$22	Say $20
Pullman berth both ways	10	.....
Four meals @ 75 cents	3.00	.....
Supper, breakfast and lodging at Pittsburg, Buffalo or Niagara, one night each way	.....	3.50
	$45 50	$23 50

We have alluded to the above merely as one of the methods by which passenger agents can manage to draw a heavy traffic to the World's Fair from the class of people who count their dimes and their pennies very carefully, and can do it without injuring their revenue from the passengers who are going to Chicago anyway. There are plenty of other methods well known in the passenger departments, and now is the time to put them into execution, while cars are running half-filled, and extra equipment ordered to meet the season's demands is bringing no returns. Every visitor to Chicago from now onward will go home as an advertisement to all his friends and acquaintances of what is to be seen there, and the sooner every crossroad's hamlet is set talking over the wonders to be seen at Jackson Park, the sooner will the great bulk of the people arouse to a personal ambition to see them for themselves.

In the Centennial year the railways made the mistake of supposing that a stated reduction from regular rates would have the same effect in stimulating travel as well advertised special excursions; but after three months of disappointing attendance they awoke to the fact that people must be induced to come by special excursion rates, and the last three months were made a magnificent success.

It is to be hoped that the history of the Centennial year may not be repeated in 1893. The time to stimulate travel is now, at the beginning of the season, when a stimulus is needed to bring the first influx of visitors from the factories and the farms. When the traffic increases to the point where all the passenger rolling stock is fully occupied it will be time to call a halt, and not till then.

THE IDEAL ENGINEERING SCHOOL.

IV.

There being so many points of difference as those we have reviewed between military training schools and those for the three other old professions, it is surely all the more significant that in one point they are agreed; their faculties are both officered and manned by men of actual training and of considerable experience in the profession they are to teach. The theory on which all four classes of schools are organized is identical, that the only proper persons to teach any profession, and especially to direct the teaching, are those who have previously acquired a considerable standing and a long experience in the practice of it. As a consequence, every military and naval school on this continent, every law school, every medical school, every divinity school, with possible rare exceptions unknown to us, which only suffice to prove the rule, is headed by a man of long prior experience and pretty high acquired standing in the practice of the profession which he teaches; and the same is nearly as true of a large majority of the subordinate professors.

As these are the only kinds of professional schools which have existed more than half a century, it is a reasonable inference from this almost the only point of agreement between them, that it is founded on strong reasons which apply alike to any kind of professional training school, and what some of these are is evident at once. A candidate for any profession needs to be trained not only in book knowledge of it, but in its spirit and essence and manners and customs, so that he may show its esprit, and feel at home in it as soon as possible. It is a perfectly reasonable inference that the ideal engineering school, when it comes to exist, will have the same peculiarity, and that if the real ones have it not it is only because the demand for engineering education has sprung up so suddenly that its practice has not yet had time to shape itself upon rational lines.

Certain it is that they have it not. We beg the pardon of the exceptions, but with those exceptions, where in all this broad land is there a single engineering school headed and managed by a man who is first and foremost an engineer and not a teacher, or who was an engineer of long experience and standing as such only before he became a teacher? We pause for a reply, and will set the limit as to what we consider "long" experience at 15 years of solid practice after graduation or 20 years without graduation, which is about the limit of other professional schools for such positions.

There are all sorts of other men at the head of our engineering schools, eminent scientists, brilliant experimenters and lecturers, skilled geologists and chemists, engineers who acquired a very excellent junior standing before they were diverted into teaching, and sundry doctors, lawyers, ministers and what not—but where is the engineer pure and simple out of all the 150 or so heads of as many separate schools?

Now, we are not so unreasonable as to expect the head of every engineering school to be an engineer of standing, especially in view of the newness of engineering as a profession, but surely it is a suspicious and significant fact when we find that there are no such men, or practically none. Is it then true that engineering practice does not develop men competent to direct the training of those who are to follow in their footsteps? Or, not unless they have been caught very young, before they are contaminated by too much practice in it? If so, we had better close the schools, for the fountain cannot rise higher than its source. We deem another explanation more reasonable.

Much the same state of things exists among the professors of engineering. A professor in a medical school of good standing we know at once to be a distinguished specialist in the branch he professes. Is it so in engineering schools? We all know that it is not, and we have in part already seen a reason why it cannot be very easily. Engineering is not a purely intellectual profession; far from that. It is mainly a practical profession; the art of directing practical work to practical ends in a scientific (knowing how) way. Therefore, although the medical graduate continues the same line of study for life, and becomes every year more competent to teach medicine to others, the first necessity for the engineering graduate is to escape from the scholastic tone and spirit of the school, to plunge into the practical work of life, and to grow rustier and rustier in the kind of knowledge which would gain him an offer of an engineering professorship.

But is not this the severest arraignment of the average engineering school which could be made? What is to be said in favor of that kind of training for any calling whatsoever, profession, business or trade, in which no necessity arises in any department for seeking first the men of long practice in it, as men of long practice in it, in order that they may give to students the knowledge that they have gained in that practice and not out of books? Does not that school stand condemned ipso facto, as at least not ideal?

One has to admit that the "business college" is not usually headed nor footed by successful business men, and that business life of any kind does not usually tend to fit a man for training the young for business life, or at least, that that kind of talent is not usually sought for in order that the budding business youth may be properly trained. If, as some claim, engineering is properly no more a profession than manufacturing or contracting, being only another form of business life, this makes a certain analogy tending to show that things are just right as they are in engineering schools. We endeavor to be fair and we note this analogy and admit its soundness to this extent: Engineering, military life and business life have this in common, that success in them depends primarily on certain natural or acquired practical aptitudes, which cannot be written down in books and hence cannot be fully (note the fully) taught in schools, however perfectly the teacher himself may have acquired them.

When we find any school of this class, therefore, doing what it may to teach in part what longer life alone can teach up to the measure of the student's capacity; when it not only seeks to give this fragment of definite knowledge but also does all that may be from first to last to grind into the student the spirit and aim of his future calling, and to bring him mentally and physically into touch with it—that, we may admit, is all that may reasonably be asked. The military schools do this. Do the engineering schools?

They do in a certain way; some much more than others. They all admit the desirability of doing so. Many of them have made some beginning in this direction, and most of them are doing a little more and more each year. But lest we may be accused of dealing too much in generalities we will descend to particulars. There are some two dozen distinct specialties in engineering, and there are four or five men in each, and in most of them more, who have acquired by practice what is, humanly speaking, complete mastery of that specialty. How many of these men are giving any instruction in any engineering school in those specialties? How many of them have ever been asked to do so? In the medical profession the instruction is given almost exclusively by this class of men, and generally at very low cost to the schools. The same is largely but less universally true in other professional schools—except in engineering schools. Why this distinction?

Within the past few years only a faint beginning in this direction has been made by a number of schools, by asking the better known engineers to deliver a lecture before the students. Except as a recognition of a principle it amounts to nothing. It is an absurd way to seek to give students practical instruction or (what should be regarded as just as important to the schools) to get practicing engineers into the way of communicating some of their practical knowledge to students. The inevitable effect is that the lecturer gives a more or less popular talk on what happens to be the uppermost hobby in his mind for the moment, and that neither he nor the students gain much from the effort. Moreover, a special cause prevents success in this line. Taciturnity is the natural characteristic of a good engineer, as we have seen. His calling is to do things; he has no practice in talking, and at the mere suggestion that they shall "lecture" many of the best of them shut up in their shells at once; and not without reason, for their first effort in that line is likely to do them anything but justice.

But those men are full of knowledge which they can talk about well when not "lecturing." Give them a little practice, certain yearly responsibility for giving the latest and best in a special department, and opportunity to gather in the things they wanted to say gradually, and a dozen or so of such short courses yearly would insensibly instill into the students the spirit as well as the book-records of engineering practice, while it would also develop a new field for engineering work which would add a little to income and more to prestige (if it became known that only first-rate men were thus engaged), and so, before long, transform the whole spirit and tendency of our engineering schools; for it would also serve the important end of bringing the regular professors more into touch with the rest of the profession, instead of a class apart. They in their turn might then be less purely professors and more practicers, and thus a double gain result.

This last is an important point. There are now nearly 200 professors of civil engineering in the United States, and 300 or 400 other professors of other branches of engineering. Speaking in the large, and without regard to a very few notable exceptions, the way in which these professors happened to become such may be stated thus: A third of them or less went directly, or within a year, from the graduating class into an instructorship and thence to a full professorship; but this is not the rule. A general desire for a certain amount of practice is felt, so that as a rule the future professor has had from two to five or six years' practice in junior grades before his appointment. Then he strikes a dull time and is tempted by some offer from an engineering school like one that happens to reach our table at the moment. A professorship ad interim for one year is open at a salary of $1,800. He takes it, gives satisfaction, and continues in the work.

Once in it he has a good deal of leisure time, not only in vacations, but throughout the year. That is the greatest temptation to many to enter on the work. It is felt that it is proper that he should engage in practice as much as possible, and he is encouraged to do so as much as possible. Much official work, especially, is secured by them from the town, city, county or state, or the national government; and what is more, we feel very sure, particularly well and faithfully done. Let no man think we are undervaluing or depreciating these able and faithful men. For a large number of them we feel not only a professional but a personal regard and respect. But the fact remains that the work most of them do after appointment is of a specialized kind, and does not bring them or keep them

in touch with their professional fellows as the medical professor's practice does, for example. They tend far too much to become a class apart. It is unjust to them, to their students and to the rest of the profession that it should be so.

That this is true as a fact is curiously illustrated by a circular for the "General Division of Engineering Education," of the "World's Congress Auxiliary of the World's Columbian Exposition." We quote from it in fragmentary fashion, but fairly.

"The undersigned (six professors) are appointed a committee to arrange for a conference in Engineering Education. The scope of the conference will include all matters relating to the course of instruction and equipment of institutions. It is confidently believed that much may be learned from a conference of leading engineering instructors. Steps have already been taken to secure papers from leading engineering educators, and a number have signified their intention to attend. The committee proposes the following list of subjects:

1. Present state of engineering education.
2. The ideal engineering education.

* * * * * * *

16. (Next to the last) Views of practicising engineers as to the needs of engineering education.

The Committee of Arrangements will have the active aid of an Advisory Council, composed of eminent engineering educators, selected from different countries.

Now, substitute the word "Medical" for "Engineering" in the above announcements, and see how strange and unnatural it would sound to talk about a conference of leading "Medical Educators" with not a word to say or to imply that their advice was sought as "medical" men, and not as "educators," and without a word to say or to imply any interest in the opinions of medical men, not educators, except "sixteenthly," then only as to "needs," not present practice. The indication is the more positive because it was so plainly unconscious. Had there been any suspicion that a criticism like this would be made on the circular they would have changed it, for it is obviously only reasonable that engineering educators should show a little real interest in learning what engineers who are not educators thought of their work; but they are becoming so accustomed to carry on their work as a thing apart, in which the engineer has no interest after he graduates, that it never occurred to them.

Whether this tendency is in any way discoverable also in the detail work of the schools we will see when we come to consider the detail features of the course of instruction, which we will next do. Owing to a brief absence from the country of the writer, however, it will be necessary to postpone the completion of these articles for a week or two.

THE PAY AND STANDING OF CIVIL ENGINEERS.

In a communication to the engineering students of Dartmouth College, Mr. B. S. Church, late Chief Engineer of the New Croton Aqueduct, takes up the subject of better pay and broader professional recognition for civil engineers. As he says, no profession is so poorly paid; $10,000 per year is considered an excellent equivalent for the best professional talent; $2,000 to $3,000 is good enough, and $1,200 to $1,500 may be taken as the average annual pay that capable, educated and experienced men are sometimes compelled to accept. Yet the men even in receipt of the lower salaries here named frequently are in charge of hundreds of thousands of dollars worth of public works, the proper and economical execution of which depends upon their personal experience and judgment; and the works in charge of men of the higher grade represent millions in expenditure. In England, on the other hand, engineers of the highest rank receive a percentage on the cost of the work in their charge, as architects do in this country, and on great works their compensation may thus amount to $50,000 or more per annum. Mr. Church believes that the poor pay of American engineers is due to the habit of fixed salaries suggesting limitation, and to a lack of any organized effort on the part of the profession to reform existing methods. He says it is for the fresher, younger engineers to seek to place the profession of engineering where it should be; to determine on a professional code; and to arrest the apparent downward trend of the last 30 years, in permitting acts among members of the profession to pass unnoticed now that in earlier years would have been inadmissible among men of a delicate sense of honor.

As Mr. Church says, the difficulties in the path leading to this better state are many and great, and the effort to change a fixed custom is discouraging and slow work. But individual effort, broadened out in time to well directed united effort, may accomplish much. In this country, the swarm of young engineers annually entering the profession is so great and the competition so sharp that low salaries in the lower grades will most probably remain the rule indefinitely. And until the engineer has gained very considerable experience and is fully capable of designing and superintending important works, the question of the amount of his salary should not be a serious one. The young engineer must remember that his opportunities for gaining professional knowledge and experience in actual practice are worth everything to him; and that his future advance and professional status will depend very largely upon the use he makes of these opportunities. But when the engineer is actually an accomplished engineer, in the proper sense of that word, we agree with Mr. Church that he should receive compensation more in accord with the practice in other professions and with the extent of his necessarily long training and responsibilities. How this end is to be arrived at we frankly admit we do not know. It is true that some prominent English engineers receive seemingly enormous sums on a percentage basis; but these favored engineers are few in number compared with their brethren who receive salaries even less than our own, on an average, or serve a long apprenticeship without any salary at all and pay their masters for this privilege. In Europe, again, the average pay of engineers is small, though, as they are usually in government service, they have practically permanent employment and a small pension awaits them when they retire from active practice.

The average compensation of young American engineers is now generally in excess of the corresponding grades in other countries, and fully equals, if it does not surpass, the average income of beginners in the other professions. Consulting engineers, with the practical and technical training and experience that begets confidence and means reputation, can now practically fix the amount of their fees; and by more united effort they could much enlarge both their field of action and their incomes. The chief trouble lies with the fixed salaries paid to trained and capable engineers who are in direct charge of and are responsibile for the proper and economical construction of public works involving the expenditure of large sums. We do not believe, with some, that the engineer should divide in any way the profits of an enterprise in his charge with the investor of capital; for such a policy would inevitably lead to corruption and tend to strip the profession of its chief jewel, unswerving fidelity to trust imposed. But the employers of reputable and skilled engineers should consider more than they do that in every case this skill and experience represent to them a direct saving in money expended; a saving proportioned in amount to the extent and ultimate cost of the work, and worth paying for liberally.

In all controversies of this nature, it is the usual custom to contrast the enormous fees sometimes paid to lawyers, doctors, or architects, and the large annual incomes of certain members of these professions with the possible returns from the best engineering practice. But it should also be remembered that these very large fees are exceptional in the more favored professions, and are of comparatively late growth. The fees of the leading physicians and lawyers of even a generation ago were very modest when viewed from a modern standpoint; and as late as 1824 William Strickland, the then leading architect in the United States, was paid $250 per month for planning and supervising the erection of the United States Bank, in Philadelphia. We will admit that individual incomes of engineers of the higher grades are much smaller than the individual incomes of lawyers and doctors of corresponding reputation. But when engineers unite in an equally close corporation; are equally jealous of the standing of engineers and compel all members of the profession to be guided by equally rigid ethical standards of conduct, then, and only then, can they look for the best compensation possible for the highest grade of service.

Many of the employers of engineers have not yet learned that obtaining an engineer "at the market price," or by "competition," in fees to be charged, is usually an expensive economy. And as long as engineers of reputation will enter into these competitions or use any but the strictest professional means of obtaining such employment, just so long do they tend to lower their professional standing and the amount of their fees. Corporations or municipal authorities would not advertise for a doctor or a lawyer, and judge of his fitness for important duties to be performed by the relative smallness of his fee; and yet this is frequently done when a new drainage system or a new water supply is contemplated. The fact of the matter is that engineers, as a class, must first respect themselves more than they seem to do; draw the line more sharply between the past-masters and the beginners in the profession, and lay down rules for the regulation of engineering courtesy and conduct and stick to these rules. It is by this strict regulation of attainments and conduct that the other professions named have attained their ends; and engineers must sooner or later do the same.

The engineer, however, has one very valid plea for higher salaries, as compared with the annual income of members of the other professions, and that is the uncertain nature of his employment. The young lawyer or doctor may have just as hard a struggle to gain a place in his profession, and may be paid less than the engineer while struggling. But when he does gain a footing he has something which is his own; and it will grow in strict accordance with his increase in experience and knowledge and attention to his business. The engineer on a salary, on the other hand, is subject to many changing conditions, with which his personal attainments or practical experience have nothing to do. A change in control may turn him out of a comfortable berth that he has filled satisfactorily for years; or a financial crisis may wreck the capital backing his work and suspend all operations, including the pay of the engineer. In either case he must seek for new employment and consume his savings, if he has any, in this operation of longer or shorter duration, according to the general tendencies of the times. In proof of this we have the fact that engineers, dependent solely upon their practice, usually die poor. The consulting engineer, for similar reasons, is justified in charging a round fee for professional services; for to obtain his necessary and special knowledge he has spent the best years of his life in gathering and digesting information under the conditions named above, and this accumulated skill and experience, so hardly gathered, should be well paid for by those who avail themselves of it.

It will take time to bring about any reform in this matter, for engineering is the youngest of all the recognized professions, in its present form, and differs widely from the others in its methods of practice. Engineers must pass through the same schools of professional experience from which the older professions have practically graduated. By more thorough organization and by first of all respecting themselves and their profession more than they seem to do, they should in time educate the employers of engineers and teach them what the term engineer really means; how much they are dependent upon the skill, experience, judgment and honesty of men so engaged in the conduct of the enormous works that mark the century we live in above all others; and, finally, teach them what all these qualities are worth in dollars.

The lawyers or doctors who enjoy abnormally large fees have first made a reputation for themselves by their talents and have taught the public that if they want the best talent and experience for especial ends, they must employ these men and pay the price they fix. Cheaper men may be had in every profession, and this condition will probably always remain unchanged. But while many men insist upon the best at any price that the professions of medicine or law afford, because their lives or their property is at stake and the personal interest is paramount, they do not yet recognize how large a personal or financial interest is embodied in the employ of a thoroughly competent engineer. They have not yet learned to know and respect the profession of engineering as they do the others; and as engineers are most interested in forcing this knowledge upon the public, it remains for them to formulate means and to work toward this end. It will come in time, as it has with medicine and law, but judicious and united action can hasten the event.

LETTERS TO THE EDITOR.

THE STATUS OF ENGINEERS AND A PROPOSED PLAN FOR IMPROVING IT.

Sir: Kindly permit me to add my mite to the present discussion on the status of the civil engineer, and to propose what seems to me a feasible plan for improving upon existing conditions. Any hope of elevating the profession of engineering by legal enactments, as in the case of the legal and medical professions, must be given up until the profession has been elevated by the engineers themselves.

When engineers themselves are slack regarding the conferring of titles, it is no wonder the public are puzzled when employing an engineer. When a young man knows how to run a level, it may flatter him to be called an engineer, but it hurts the calling. A man who can turn an angle on a transit and resurvey town lots is not necessarily an engineer; but if other engineers call him one, the people certainly have a right to do so, and no blame can attach to him if he undertakes work given him, although no real engineer would trust him with it.

Yet the question of standing has generally been contended as hard to settle because of the relations of engineers toward their employees and each other. Engineers may be in private practice, they may be employed on salary by a corporation or individual, or they may be employed by other engineers. Only some plan providing for all these cases can be successful.

The writer believes this can be done by the organization of a society in each state, or, better, a national society, with different grades of membership and a strict code of ethics, binding members to employ no one in a professional capacity except fellow members, and to recognize no one as an engineer, no matter how able, except he is a member. Rules of professional conduct, similar to those in other professions, can be adopted and enforced.

Employers of engineers will then soon understand that among members of this society they can surely find competent men, while outside the ranks it is a doubtful experiment to take anyone.

The different branches of engineering can each have a society, and I here outline a plan for a society (or council) of civil engineers which seems to me to be feasible: There should be four classes of members, and this is necessary because a large number in the ranks never studied engineering at a school, and this proportion will always be large. A man should not be prevented from becoming an engineer because he was deprived of the benefit of a college training, but it should be so arranged that he could readily attain to full standing when he shows a disposition or the ability to do so. While it is desirable for an engineer to have a thoroughly good theoretical training, it must be remembered that not all of our best engineers are graduates.

This society should have Student Members, who should be young men over 20 years of age, of good moral character, and recommended by three Members. They must show that it is not possible for them to attend an engineering school, and shall pass an examination in algebra, through quadratics, plane geometry, elementary trignometry and mensuration, practical geometry, orthographic and isometric projection, the plotting of compass surveys, and calculation of areas. Upon completion of this examination, a certificate should be given, stating the examination passed, and enrolling the young man as a Student Member.

Junior Members should be young men over 23 years of age, of good moral character, who are recommended by three Members who have employed them. They shall have had three years' experience at least in engineering, and possess a Student Member's certificate. In addition, the Junior should be examined in higher algebra, solid geometry, higher trigonometry and elementary physics, chemistry, astronomy and geology, surveying, as treated in standard textbooks, topographical and map drawing, with some knowledge of mechanical drawing. The satisfactory completion of this examination should entitle him to enrollment as a Junior, and entitle him to a certificate to that effect, stating also that he is regarded as a competent surveyor.

Associate Members should be young men over 25 years of age, of good moral character, and recommended by three Members who have employed them. They should have had at least five years' experience in engineering. In addition to subjects required at examination for Juniors, they should be examined in elementary mechanics, foundations, calculations of strains in structures, water supply, sewerage and drainage, and should submit a design for some structure. They must be well up on the subjects of materials of engineering, and otherwise give evidence that they are competent to perform the duties of a civil engineer. Upon passing this examination the young man would be enrolled as an Associate Member, and receive a certificate to that effect. He may then style himself a civil engineer, but cannot put after his name the letters C. E., for that is reserved for Members alone.

A Member should be a man of good moral character, and one who has been an Associate Member at least five years. He must be over 30 years of age, and recommended by five Members as an engineer and a gentleman. A Member shall have the right to assume the title and degree of Civil Engineer, and use the distinguishing letters as a part of his signature. Members alone can vote and hold office.

College-trained engineers may be admitted to all classes of membership without examinations, except in the regular college course upon the following conditions: Undergraduates shall be enrolled as Student Members when 25 years of age; graduates over 23 years of age shall be enrolled as Juniors; graduates with at least one year's experience and over 25 years of age shall be enrolled as Associates.

Students styling themselves surveyors or engineers; Juniors calling themselves engineers, and Associate Members signing C. E. after their names should be dismissed from the society. No other restrictions should be placed on practicing. So long as a man calls himself what he is, he can take any work he feels able to do, and charge what he pleases.

The responsibility for bad work will then be thrown upon the employer, and the ambition of the employee is his safeguard. If the latter wishes to imperil his standing or reputation, he is free to do so, but continued mistakes should bar him from advancement. The society should only endeavor to ascertain that a candidate for membership has a working knowledge of the fundamental principles of engineering science supplemented by several years' experience. Any attempt to have examinations and certificates in specialties should not be permitted.

Ernest McCullough,
Civil Engineer, M. Tech. Soc. P. C.

San Francisco, Cal., May 11, 1893.

(We devote considerable space to the plan of Mr. McCullough, because a number of the younger engineers especially seem to think that it is along these lines that the wished-for improvement in professional status and public recognition must come. The plan as given above would require much reworking before it would be acceptable to the mass of engineers, and before the national society proposed could have that prominence and influence that could alone bring about improvement upon existing conditions. Any successful movement in the direction proposed must be of a kind that will gain the support of all engineers worthy of the title; without this general support any movement will fail. For ourselves, we approve of a better and broader organization of American engineers of all classes which has for its end the purification of the professional atmosphere, the clearer recognition of the status of the several grades of engineers among themselves and before the public, and finally the fixing of this status and the deportment of engineers toward each other by well-formulated, workable laws. The trouble is that no scheme of reorganization embodying these ends has yet been presented in a manner that will induce engineers as a body to seriously consider it.—Ed.)

RAILWAYS IN CAPE COLONY.

Sir: You are probably conversant with the Cape Colony railway systems. The coming Parliament (to meet early in June) will very likely discuss a bill to be brought in by the government for railways in coast lands, between the Western system and the Midland system, whose ports are respectively Cape Town and Port Elizabeth. This part of the country is known as the Southwestern district, and the natural port is Mossel Bay. Lines have been surveyed from Constable, on the main line, Western system, through Ladismith and Oudtshoorn, to a point or two on the Midland railway system; and also from Mossel Bay, through George to Oudtshoorn. The latter is a heavy line—first surveyed and located in 1882-83. A range of mountains named Langeberg runs parallel to the sea coast, and about seven miles from it. The village (or town, perhaps) of George lies at the foot of Langeberg on the south, or coast, side. The range is exceedingly broken by deep valleys and gorges. The only available pass is Montagu Pass, over which the main road, with a grade of 1 in 11 or 12 (8.3%) on the range, between George (from Mossel Bay) and Oudtshoorn goes. The former located line has a grade of 1 in 40 (2½%) from the foot of Langeberg, with a tunnel 2,625 ft. long under the pass, besides two other shorter tunnels. A present survey is reducing the work at the expense of a 1 in 20 (5%) grade, over the Pass. Rumor has it that whatever route, or routes, the government will recommend, to further reduce the expense of construction, they will advise a narrower gage than the present one of 3 ft. 6 ins., ignoring the fact of new rails, ties, locomotives and rolling stock, etc., being necessary, and the extra expense entailed by a break of gage.

I am glad to say a line of steamers is going to run between New York and Cape Town, much to the advantage, I opine, of this colony, and South Africa generally. I trust, then, to be able to have a back volume of your paper sent out to me, and to subscribe by volume, unless there is a cheaper postage from the states.

Yours truly,
H. C. Litchfield.

Queenstown, Cape Colony.

(The Cape government railways are of 3 ft. 6 ins. gage, and there is no economy in a narrower gage, but a great disadvantage in the necessity for special equipment and in break of gage. The theories of advantage in economy and efficiency of a narrow gage, particularly when it is a link of a wider gage system, have been exploded long ago, and we hope the engineers will convince the government of its incorrect view in this point. The sleeping and dining car service on these lines was described in our issue of April 27. The first steamer of the American & African Steamship Line, the "Worcester" (3,000 tons), sailed from New York, May 25, with a cargo of mining machinery, lumber, etc. The steamers will run monthly, and carry passengers, mail and freight, the length of trip being estimated at 30 days, and will call at Cape Town, Algoa Bay (Port Elizabeth), East London and Natal (Durban), and also Mossel Bay, Delagoa Bay, Mauritius and other places when special inducements are offered. The line is in the interest of the Donald Currie Co., which runs the Castle Line of mail steamers between Southampton (England) and South Africa.—Ed.)

FINDING THE ARC OF A CIRCULAR SEGMENT.

Sir: As noted by Mr. Tuttle in your issue of May 18, there was an error in the formula as printed in your issue of April 27. The correct formula is as follows:

$$\frac{R^2}{2}(\text{arc } A - \sin A).$$

I do not wonder that Mr. Tuttle thought that an error had been made; but the most serious error, the omission of the exponent after the letter R, he does not mention at all.

T. P. PERKINS.

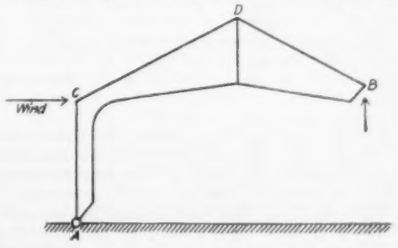
Lynn, Mass., May 25, 1893.

(In our machine typesetting we have not the Greek letter used by Mr. Perkins to indicate central angle, and it was marked out of the original copy with the intention of making a substitution, as above, but the copy went to the printer without the substitution being inserted. We received other letters relating to this formula, but none of them noticed the omission of the exponent.—Ed.)

A QUESTION OF REACTION.

Sir: A difference in opinion as to the nature of the strains in a certain roof truss having arisen in our office, you are appealed to as referee.

The general shape of the truss is shown in the accompanying sketch (not drawn to scale). It is pin-connected at A, and supported at B in such a manner that no horizontal resistance is offered there, i. e., the



support is in the nature of rollers. One-half of the wind force acting on AC is applied at C. B is at a higher level than C. The effect of the wind acting on CD is disregarded in the discussion.

Now, what is the nature of the vertical reaction at A? Is it up or down? In other words, does the truss tend to revolve in an anti-clockwise or in a clockwise direction about the point B? Does it require a support at A, or need anchoring down at that point.

W. B. C.

Chicago, Ill., May 24, 1892.

(Under the above assumptions we would say that the wind pressure would be transferred horizontally to A: and if this point were free to move it would move to the right in a horizontal plane. An anchor, therefore, would be required.—Ed.)

NOTES AND QUERIES.

M. T., of Catanzaro, Italy, wishes to know why we do not state the price and publisher of the books reviewed in our columns, and refers to the notice of "Irrigation in India," in our issue of March 30, 1893.

In quoting from the title page of this work in the

review it was stated that the work in question was an "exract from the twelfth annual report of the U. S. Geological Survey," from which our American readers would understand that the work was a public document and had no price. In other words, we state for the benefit of our foreign readers, all of our national public documents, with one or two exceptions, are printed at the Government Printing Office, Washington, D. C., and distributed gratis on application by heads of the departments particularly concerned in the respective reports or by members of the National Legislature, the liberality of the distribution depending upon the number of reports available.

Public documents printed at the expense of states or municipalities are distributed in the same manner as outlined above.

When the publications of the national government cannot be obtained in the ordinary way they can often be purchased from J. H. Hickox, 996 M. St. W., Washington, D. C., or other booksellers.

A DAY ON THE CHICAGO DRAINAGE CANAL.

Twenty million dollars! that is the sum in round figures which has gone into the creation and embellishing of the great "White City," at Jackson Park, the fame of which has spread to the remotest corners of the globe. But as a great engineering work the Columbian Exposition is rivaled by another Chicago enterprise, which has been hardly heard of outside the state of Illinois, except by engineers; and many engineers are unacquainted with the magnitude and importance of this other great work which Chicago has undertaken, and which will cost her before it is completed a sum which will exceed that which she and her citizens have put into the Columbian Exposition.

To the ordinary sightseer there is nothing on the drainage canal worth seeing; nor will there be until the work approaches completion, when the enormous piles of stone along the line may excite the wonder of the traveler. The engineer, however, may find it worth his while to take a day off from the wonders of the World's Fair, for the sake of studying on the ground the actual prosecution of one of the greatest engineering works, measured by the standard of dollars and cents, that is now under way in the world.

Readers of Engineering News are already familiar with the general scheme which is involved in this canal; but a brief rehearsal of its plan may save a tax on the memory. The Chicago River, shown on the accompanying map (reproduced from our issue of June 3, 1892), has a sluggish movement, sometimes toward Lake Michigan, and sometimes from the lake east into the Des Plaines River, which flows into the Illinois and thus to the Mississippi. Chicago proposes to aid the flow toward the Des Plaines so that the current shall always be in that direction. Thus the city's unique location on the shore of a great inland sea and at the summit of a watershed will enable it to take water from the pure and inexhaustible supply of Lake Michigan and discharge its sewage over the summit of the watershed to the Mississippi Valley, diluting it with enough lake water to prevent any nuisance.

All this sounds simple enough in theory, but practically the engineering problems involved have been numerous and difficult. We may undertake their discussion at another time. At present it is sufficient to say that what Chicago has set about is to dig a ditch 160 ft. wide, 18 to 50 ft. deep and some 26 miles long, over one-half of it in solid limestone. This ditch is to be dug for the most part through the flat bottom lands along the Des Plaines River. Most of the location is in fact covered by the overflow from the river and will have to be inclosed by cofferdams and pumped dry before the actual excavation can be started.

There is little of the picturesque about this work, and little to attract the attention of the ordinary observer. It is digging pure and simple, in a flat monotonous valley; a cheap little mountain railway or a pretty piece of bridgework would impress the ordinary traveler more than the whole canal. Nevertheless, the fact remains that this open ditch involves an amount of labor and expense—aye, and skill and energy, which entitles it to rank as one of the great engineering works of the world. Indeed, if we accept the Trans-Siberian Ry. and the Manchester and Baltic ship canals, the writer does not recall an engineering enterprise now being actively prosecuted anywhere in the world which involves a greater expenditure.

It is not easy for even an engineer to comprehend the enormous bulk which the 12,000,000 cu. yds. of rock excavation and as much more earth excavation on the Chicago drainage canal represents. Let us make some comparisons: There is five times as much rock excavation in this work as there was in the whole construction of the new Croton aqueduct tunnel, 30 miles long. Again, if the whole spoil bank of rock and earth from Chicago's great ditch were used in building pyramids, a half dozen the size of Cheops would rise from the plain.

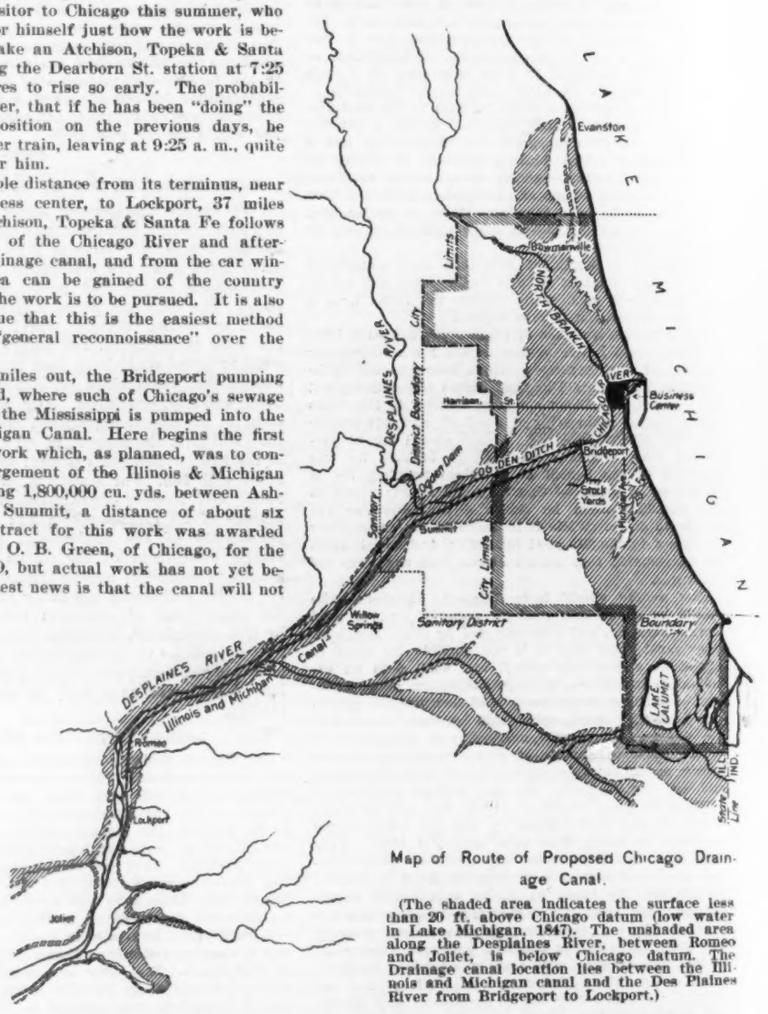
Comparing this canal with other great canals we have, in round figures:

Canals.	Total excavation, cu. yds.
Chicago drainage canal	24,000,000
Corinth ship canal	11,000,000
North Sea and Baltic ship canal	67,000,000
Manchester ship canal	48,000,000
Suez canal	98,000,000
Panama canal	200,000,000
Nicaragua canal	70,000,000

So much for the magnitude of the enterprise. The engineer visitor to Chicago this summer, who wishes to see for himself just how the work is being done, can take an Atchison, Topeka & Santa Fe train, leaving the Dearborn St. station at 7:25 a. m., if he cares to rise so early. The probabilities are, however, that if he has been "doing" the Columbian Exposition on the previous days, he will find the later train, leaving at 9:25 a. m., quite early enough for him.

Along the whole distance from its terminus, near Chicago's business center, to Lockport, 37 miles distant, the Atchison, Topeka & Santa Fe follows the course first of the Chicago River and afterward of the drainage canal, and from the car window a fair idea can be gained of the country through which the work is to be pursued. It is also emphatically true that this is the easiest method of making a "general reconnoissance" over the line.

About three miles out, the Bridgeport pumping station is passed, where such of Chicago's sewage as now goes to the Mississippi is pumped into the Illinois & Michigan Canal. Here begins the first section of the work which, as planned, was to consist in the enlargement of the Illinois & Michigan canal by dredging 1,800,000 cu. yds. between Ashland Ave. and Summit, a distance of about six miles. The contract for this work was awarded last January to O. B. Green, of Chicago, for the sum of $668,300, but actual work has not yet begun, and the latest news is that the canal will not be used but a new channel will be excavated, as for the portions of the work lower down, lying parallel with the canal and about 1,100 ft. north of it.



Map of Route of Proposed Chicago Drainage Canal.

(The shaded area indicates the surface less than 20 ft. above Chicago datum (low water in Lake Michigan, 1847). The unshaded area along the Desplaines River, between Romeo and Joliet, is below Chicago datum. The Drainage canal location lies between the Illinois and Michigan canal and the Des Plaines River from Bridgeport to Lockport.)

From Summit to Willow Springs, six miles, the contracts were also awarded about four months ago, and the contractors have not yet had time to get their plant on the ground and in operation. One sees here and there as the train sweeps along lumber being hauled for building contractor's headquarters, stables and boarding shanties, but not much progress is apparent even in this preliminary work.

Between Willow Springs and Lockport is the section of 14 miles on which contracts were let a year ago, and now evidences of the task which is being undertaken multiply. The ground over nearly the whole of this section is below the flood line in the Desplaines River, a stream whose low-water mark appears to be not far below its flood-lines. Here and there cofferdams are in progress; but it is not until we reach the last eight or nine miles above Lockport that we find work really being actively prosecuted.

The engineer visiting the work at present can leave the train at Lemont or at Romeo, and find himself in the midst of operations; but if he wishes to "begin at the beginning" and go over the line of the canal, or if for the conveyance of himself or his baggage he desires a carriage he had better go on to Lockport, as the small hamlets above can not boast anything so metropolitan as a livery stable. The writer speaks from experience, however, in saying that little is to be gained in time and less in ease by riding. The roads consist of a layer of soft Illinois mud 6 ins. to 2 ft. in depth, plentifully sprinkled with chunks of stone of various sizes from a teacup to a bushel basket, and for the most part in going over the work one wishes to take short cuts across fields, spoil banks, etc., where a carriage could not go.

The headquarters of Mr. R. P. McCormick, contractor for Section 14, are about two miles above Lockport. Mr. McCormick's section includes the deepest cut on the line, through a gravel hill overlying the rock. This will be attacked with a steam shovel after the rock work on other parts of the section is well under way. Except for this ridge of gravel, there is very little stripping to be done anywhere along this part of the line. Glacial action in past geologic ages seems to have smoothed off the rock which covers the Des Plaines bottoms as level as a floor; and being overflowed by the floodwaters of the Des Plaines River a thin deposit of vegetable mold has gradually formed over the rock.

On Mr. McCormick's section the surface level is above the flood line of the Des Plaines; but going from this section toward Chicago the rock surface and also the ground surface is gradually depressed and is subject to overflow. Thus the inclosure of the work by a cofferdam and pumping it dry is the first step on all the sections above No. 14.

The accompanying illustration, reproduced from a photograph taken near Romeo, four miles above Lockport, will give the reader some idea of the work and the country in which it is being carried on. The view shows one of the pits of Mason, Hoge & Co. on Section 13, and is taken looking directly down the line of the canal toward Lockport. One of the channeling machines is shown in the foreground, and the smooth vertical wall which the channeling machine makes is seen on the right. This work of channeling, while expensive, will give an ideally smooth surface for the flow of water, and will permit boats to move through the canal at speed without danger of injury if they graze the rock banks. The channeling is the first work done after the surface soil is removed. Messrs. Mason, Hoge & Co. have sublet the contract for doing the channeling on their work, Sections 11, 12 and 13, to the Sullivan Machinery Co., of Chicago, at 5 cts. per cu. yd. of excavation, which amounts to 15 cts. per sq. ft. of wall channeled off.

The channeling machines run back and forth on their tracks, until a groove about 2½ ins. wide is cut along the outside line of the canal on each side, for a length of 75 ft. or so, and 10 to 12 ft. deep. Then the machines are moved along to a new stretch, and blasting begins on the section just channeled. After the material is taken out, the channelers will go down in the bottom of the trench and put down another groove. The contract specifies that not more than three cuts shall be taken in the total depth. The cost of the channeling increases rapidly when the cuts are deeper than 9 to 10 ft.

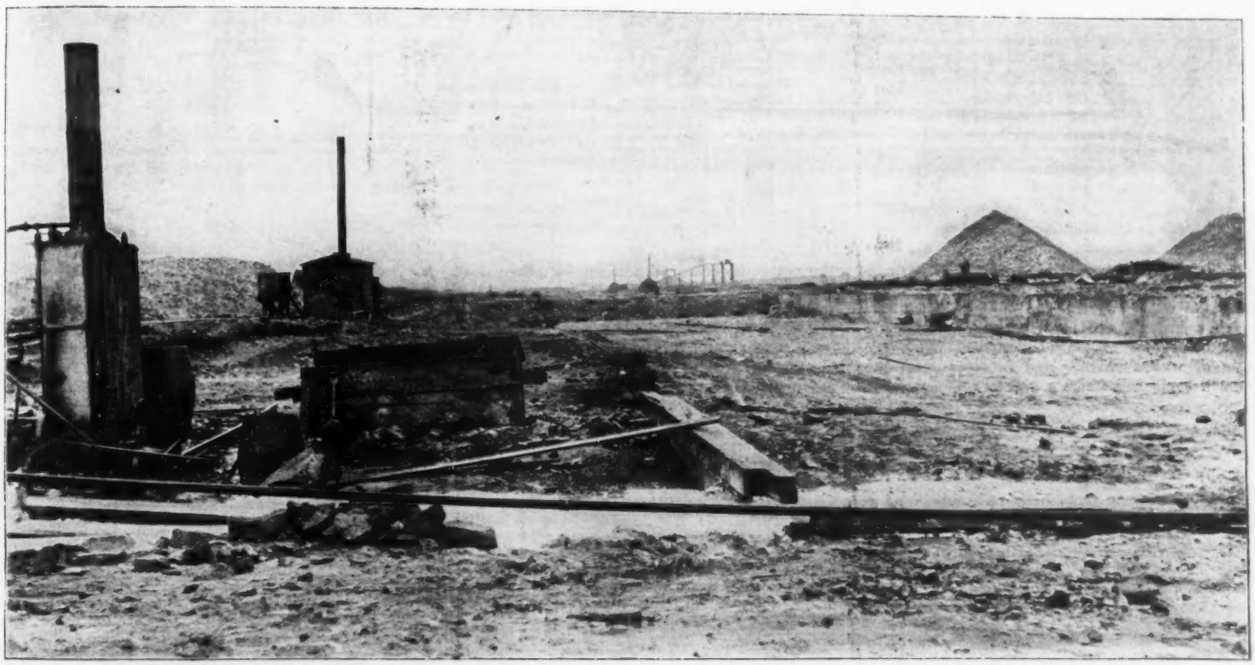
It is an interesting question whether the gain from the smooth rock face at the sides of the canal is worth what it costs; or, to put it another way, whether the money paid for the channeling might not have been better spent in increasing the width of the canal. It is fair, perhaps, to credit one-third the cost of the channeling as benefit to the contractor. It saves a certain amount of drilling and blasting, and the excavation and handling of a certain amount of rock outside the line of the canal. This leaves 10 cts. per sq. ft., or 90 cts. per sq. yd., as about the cost to the sanitary district of the smooth rock walls. As 90 cts. is a little above the average price per cu. yd. for excavation, it appears that the engineers might have made the channel 6 or 7 ft. wider with ordinary rough rock walls, at the same expense. But at a venture one would say that the larger channel with rough walls would have little greater flowing capacity, and the smooth walls are certainly far superior for boat traffic.

The low prices at which the contracts for rock excavation were let—73 to 80 cts. per cu. yd.—have made the contractors study the question of handling the material pretty closely. The work of drilling and blasting is reduced to such a science now that its cost can be calculated to a nicety; but how to get the rock out of the ditch and onto the spoil bank in the cheapest manner is the problem over which the contractors have been studying for months. Here is a solid mass of rock 162 ft. wide and, say, 40 ft. deep. It must be deposited on the west side of the canal far enough away to leave a 50-ft. strip between the canal and the foot of the spoil bank. If we take the angle of repose of the broken rock at 45° and its volume as 1.8 the volume of the solid rock, the cross-section of the spoil bank may be an equilateral triangle, and the bank will have a least width of 164 ft. and a least height of 142 ft. Practically, however, the rock will stand at a considerably steeper slope than 45°, and will not be dumped all at one point. Thus while the width of the bank will be about the figure given, its height will be much less.

A little computation shows that the average straight haul from the excavation to the spoil bank will be represented by an inclined line 213 ft. long with a vertical rise of 70 ft. The material taken from the side of the canal farthest from the spoil bank, on the other hand, must be lifted 40 ft. to the surface of the ground, and, say, 100 ft. farther to the top of the spoil bank, and must be transferred horizontally over 300 ft. To devise machinery to meet these conditions is the problem with which contractors and makers of contractors' plant have been wrestling.

At present the contractors who have started work are using for the most part dump cars and trestle inclines, some of which are seen in the distance in our illustration. The cars are hauled by mules from the face of the work to the foot of the incline, and are pulled to the top by a hoisting engine. Of course the haul increases as the work progresses farther and farther from the incline. The chief item of cost, however, which the contractors desire to lessen is the loading of the cars. A piece of rock which three or four men working together could lift onto a skip will require blasting before it can be loaded on a car. Again a man can do at least double the work throwing rock on a skip that he can when he lifts it breast high onto a car. Remembering these facts, it is easy to realize why the contractors have been looking anxiously for some kind of hoisting machinery which will carry skips from the face of the work to the dump in the quickest and cheapest manner.

Three kinds of hoisting machines have been tried, the cantilever, built by the Brown Hoisting & Conveying Machine Co., of Cleveland, and the cableways, built by the Lidgerwood Mfg. Co., and by Messrs. Copeland & Bacon, of New York city. Messrs. E. D. Smith & Co. on Section 10, have both a Brown cantilever and a Lidgerwood cableway now at work. The cantilever consists of a long light truss with an inclined floor, supported by a well braced tower resting on four 4-wheeled trucks. These travel along tracks laid along the west side between the canal and the spoil bank. One arm reaches down and spans the width of the excavation. The other stretches up over the spoil bank. By suitably arranged winding machinery the loaded skip is lifted from the pit, carried quickly to any desired point on the opposite arm and lowered to the dump. These machines can handle a large amount of material and are universally commended for their work. Their only drawback is that they are necessarily pretty expensive, and require a large cash investment at the outset of the work which will be of little value at its close. The pit shown in our engraving was excavated by the cantilever which was wrecked in the windstorm of April 7, as described in Engineering News of April 13. The conical mound is the rock which was taken out by this machine. The engraving shows the place where the machine toppled over at the foot of the spoil bank. As stated in our description of the accident, it was due not to any weakness of the truss or its supporting tower, but to the lack of brake power on its trucks. Only one truck of the four which carry the cantilever was equipped with brakes, and it was not strange, therefore, that the wind of 72 miles per hour was strong enough to overcome the brake resistance.



WORK ON THE CHICAGO DRAINAGE CANAL. FROM A PHOTOGRAPH ON SECTION 13, MASON, HOGE & CO., CONTRACTORS, LOOKING DOWN LINE OF CANAL TOWARD LOCKPORT.

Messrs. Mason, Hoge & Co., on whose work the accident occurred, have since that time ordered eight cantilever machines from the Brown Co. for use on their three sections.

The Lidgerwood cableways are similar to those which have been in use on other work except that they are mounted on trucks so that they can be moved along and kept over the face of the work as the excavation progresses. While their capacity is less than that of the cantilever, their cost is also less. Either machine, it is certain, will take out the material and put it on the bank much more cheaply than it can be handled in cars under any possible system; and a few months from now will see these plants put in operation all along the line.

Besides the delay in securing and placing proper plant, the slow progress thus far made by the contractors is due largely to the continued rains and storms. A worse winter for outdoor work has not been seen for the past 25 years, is the testimony of one contractor of long experience. With the coming of warm weather and brighter skies the work will begin to assume a different aspect.

A few months hence there will be a continuous stretch of rough board shanties along the whole 26 miles from the south branch of the Chicago River at Ashland Ave. to Lockport; and the firing of blasts and the rattle of falling rocks all along the line will make welcome music for contractors and engineers.

STEAM SHOVELS AND STEAM SHOVEL WORK.*

By E. A. Hermann, M. Am. Soc. C. E.

Part II.—Steam Shovel Work.

(Continued from page 486.)

Where the embankment has been previously widened by the excavated material from the cut,

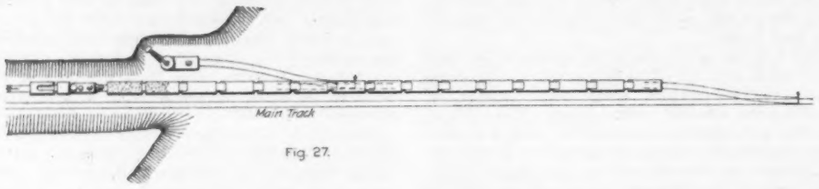


Fig. 27.

Fig. 27, a sufficient length to permit laying a side track long enough to hold the construction train, the full number of cars can be used at once, a great advantage in keeping the steam shovel at work without interruption by passing trains, which is unavoidable when some of the cars extend out on the main track.

After the machine has reached the other end of the cut it is either withdrawn for other work, or placed on the other side of the main track for widening the cut on that side. The steam shovel begins at A, Fig. 28, loading cars standing on the main track; the main line traffic being carried over a temporary main track built in the excavation previously made by the steam shovel on the other side of the main track. Only a few cars at a time can be used for loading at first, unless the temporary main track has been extended toward B a sufficient length to clear the usual string of about 20 cars when the first car is being loaded.

Grading Wide Areas.—In loading gravel for balasting, or in widening a cut for the purpose of grading yard, shop or station grounds, the usual manner of doing the work is shown in Figs. 29 to 34. After the first cut has been made by one of the methods already described the steam shovel is started in at A, Fig. 29, for the second cut. After its completion the first side track becomes available for the storage of empty and loaded cars, as in Fig. 30, greatly increasing the convenience of handling the cars and preventing delays by interferences between the strings of empty and loaded cars, when the latter cannot be taken away promptly on account of passing or shortly expected trains on the main line. After the completion of the third cut, another side track is available for cars, Fig. 31, the loaded cars are then placed on the first inside track and the empty ones on the second. The former are taken away by the road crew, and on their return placed on track No. 2. The pit crew set their loaded cars on track No. 1 for the road crew, and get their empties from track No. 2. The pit track in the rear of the steam shovel is used as a repair track for cars. After the completion of the fourth cut, Fig. 32, track No. 3 is used for a car repair and extra storage track for loads or empties, for which there may not be room in tracks 1 or 2. Enough tracks have then been built for the most efficient and economical handling of the loaded material, and if the empty cars are promptly returned the steam shovel can be kept almost constantly at work. Each pit track, on which the steam shovel advances, becomes a side track on the completion of that cut, to be used as a loading track for the next cut up to the fourth cut, after which the loading tracks are taken up on completion of the cut for which they are used, Fig. 33, and relaid in the pit of the next cut, to be used, taken up, and relaid as before for the following cuts. In pits less than ¼ mile in length, it is sometimes necessary to retain more of these tracks to provide ample storage space for all loaded and empty cars.

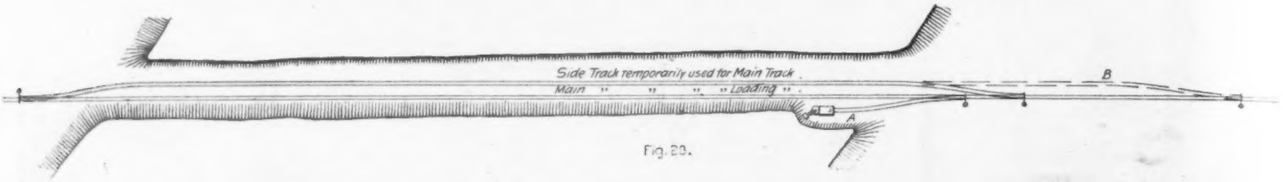


Fig. 28.

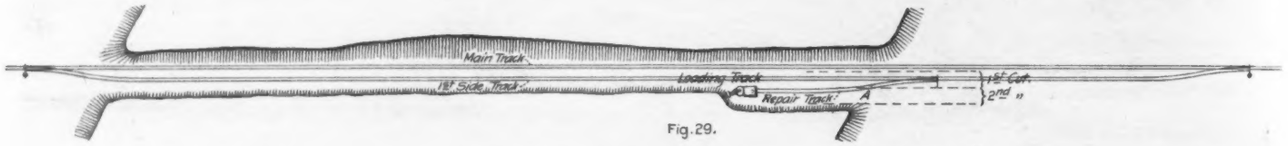


Fig. 29.

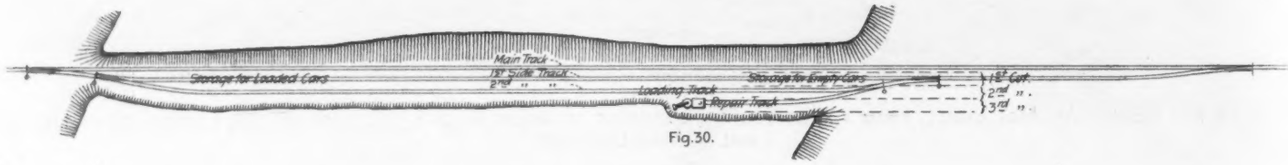


Fig. 30.

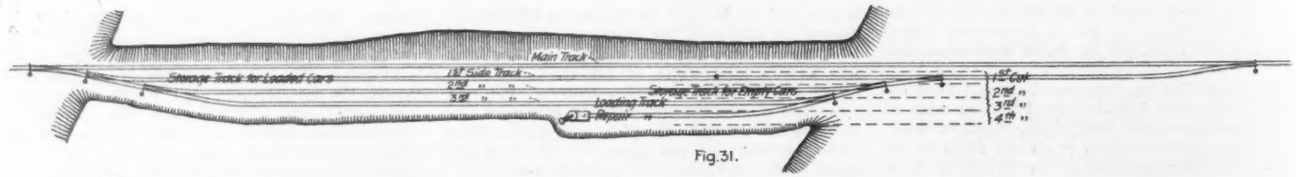


Fig. 31.

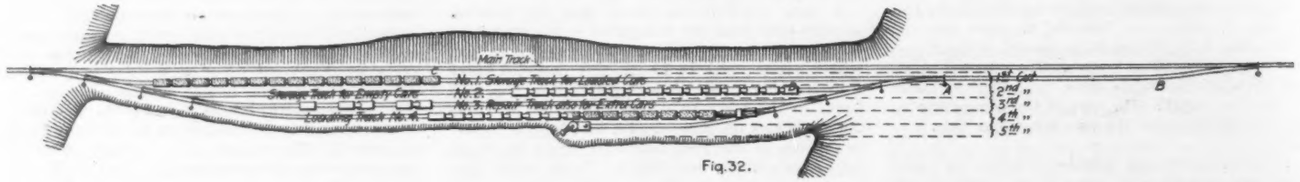


Fig. 32.

*Copyright, 1893.

On all large pieces of work where the main line traffic is heavy it is important that the first side track from A to B, Fig. 32, shall be of sufficient length (usually about 700 ft.) to hold the engine and a full string of cars to avoid going on the main

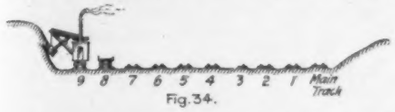


Fig. 34.

track when switching loads to C, and obtaining empties from D. If there is an embankment from A to B it can be widened with material taken from the cut, either by wagon or cars.

Grading by this method for yard, shop and station grounds occurs mostly near large cities where better terminal facilities must be provided for. The width of the area excavated in this manner seldom exceeds 200 ft. (eight cuts), except in old gravel pits used for furnishing material for ballasting track, which are sometimes 300 ft. (twelve cuts) or more in width.

Gravel pits and other wide areas excavated are seldom less than ¼ mile or more than one mile in length. One-half to three-fourths of a mile is the most usual length; in exceptional cases two miles have been reached. Long and narrow pits can be worked more advantageously than short and wide ones.

Cutting Down Grades.—For cutting down grades on railways where the traffic is not too heavy to prohibit loading on the main track, the usual plan of operations is shown in Figs. 35 to 42. The machine begins work at A, Figs. 35 and 36, the beginning point of the new grade, loading cars on the main track, cutting to the line of the new grade, and moving forward on the track on the surface of the pit as long as the height of the crane permits raising the dipper high enough over the cars to open the bottom door of the dipper and discharge its

Fig. 37.

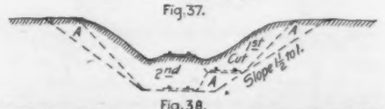


Fig. 38.

Fig. 39.

contents, B, Fig. 35. This point is usually about 2 ft. below the main track. The machine must then be gradually run upward on a cribwork of wooden blocking, generally pieces of pine 6×12 ins. × 4 ft. long, with some longer track stringers for supporting the sections of track on top of the blocking, and some thinner pieces for attaining exact heights of blocking when needed. As the machine moves forward the dipper still continues cutting to the line of the new grade, while the machine is gradually run upward on the blocking on a grade parallel to the grade of the main track, and slightly below it, maintaining a constant height between the top of the track on the blocking and the highest point to which the dipper can be raised on the crane to insure discharging its load on the cars. When the dipper has cut as low as the length of the dipper handle will permit, C, Fig. 35, the greatest depth to which the machine will cut below the level of the main track has been reached, and as the steam shovel advances the surface of the pit will be on a grade parallel to the grade of the main track, running upward to the summit, S, then downward, and continue so until it cuts the new grade line at H, when the dipper is made to cut on this grade, while the blocking under the machine is gradually lowered as it was previously raised, until the steam shovel reaches the end of the new grade at I, when it is again on the surface of the pit.

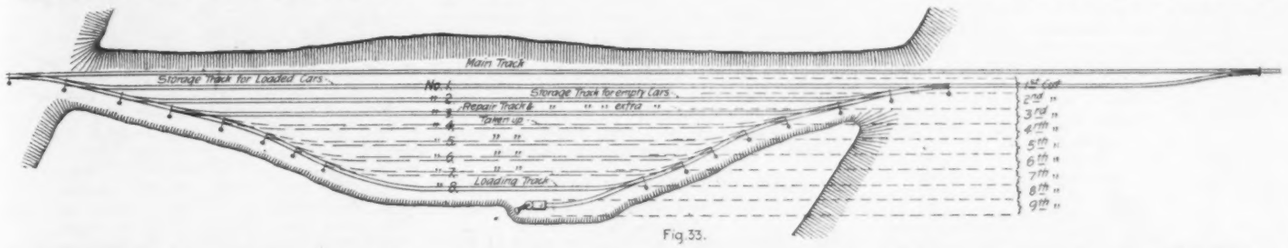


Fig. 33.

Although the machine is gradually run upward and downward, it is always blocked level after each forward move before beginning work, to insure quick and easy swinging of the crane, as previously explained. Most machines will cut 5 ft. below the main track and load on a flat car with 18 ins. side boards. Some machines will cut as low as 8 ft., and they are preferred to others on railways where much work of this kind is done, as their use often avoids making an extra cut.

Fig. 35.

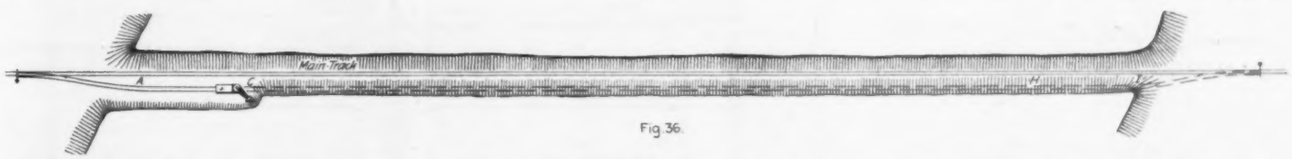


Fig. 36.

After the first cut has been completed, the pit track, A 1, Fig. 36, becomes the temporary main and loading track; the main track is taken up from C to H, and the steam shovel run back to C to be-

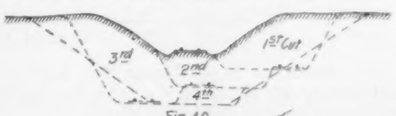


Fig. 40.

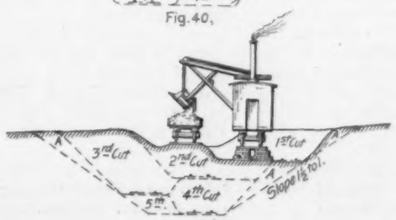


Fig. 41.

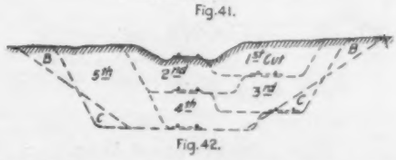


Fig. 42.

gin the second cut, Fig. 42, excavating it in the same way as the first, and loading on the temporary main track. This track again is taken up after the second cut, the machine begins at D and ends at G for the third cut and loads on the pit track in the second cut; the fourth cut is made in a similar way, the machine beginning at E and ending at F, Fig. 36. The fifth and last cut is merely a widening cut, made by loading on the track in the pit of the fourth cut. The material of each cut after the first is loaded on the track laid in the preceding cut. After the completion of the last cut, the permanent subgrade having been reached, the main track is laid on the permanent line, and the small quantity of material obtained from cutting the ditches loaded on cars by hand and taken away for unloading. The most frequent depth of cut made at the summit of grades is about 10 ft. (two cuts), Figs. 38 and 39.

When the main track is on a curve, as frequently happens, an extra cut can often be avoided by slightly changing the alinement of the new main track, Fig. 43, and at the same time reducing the degree of curvature. This is particularly applicable where an odd number of cuts must be taken to reach the bottom of the new grades. The dipper will cut to a slope of about 1 to 1. When greater slopes are required, it must be done by hand or undercutting resorted to. Sloping by hand is slow and expensive work, impracticably so in all tenacious materials; it has therefore become the exception, and undercutting the rule. Cuts made in the latter manner sometimes present a rather ragged appearance when just completed, but the irregularities soon merge into a smooth surface as the action of the elements produces the natural slope of the material; the smaller cost amply compensates for the temporary lack of finished appearances. The amount of hand labor necessary where undercutting is not practiced is shown by the sections A in Figs. 38 and 41. This can be entirely avoided by undercutting the slopes, as shown in Figs. 39 and 42; the sections B will slough off within a year or two and most of the material lodge in the spaces C; a small part of this material may roll to the bottom of the cut, and can be removed by loading on cars by hand, or space may be provided for it by making the cut a few feet wider at the bottom. In most cuts for reducing grades this extra width must be cut out anyhow to provide room for both steam shovel and loading track.

(To be continued.)

A COMPROMISE SYSTEM OF LIVE LOADS FOR DESIGNING RAILWAY BRIDGES.

The question of the proper assumption for rolling load in computing bridge strains, whether to take the actual spacing and loads of the separate wheels of one or more actual locomotives or to do with the locomotive load as is done with the load, assume a simpler loading which represents with practical accuracy the effects of the more complex "actual wheel loads," is one which comes home to nearly every practicing engineer. Most of our readers will remember the able discussion of this question by Mr. J. A. L. Waddell, M. Am. Soc. C. E., in his paper on "Certain Disputed Points in Railway Bridge Designing," read before the society in 1891 (Eng. News, Dec. 12, 1891). It will be remembered

that in the discussion which followed this paper a very large proportion, if not a majority, of the engineers taking part expressed their disbelief in the practical value of the generally accepted method of computing bridge strains by "actual wheel loads," and suggested some modified system which would entail less needless labor, and not detract from the practical accuracy of the results.

To bring out still further the opinions of engineers on this point Mr. Waddell in November of 1892 addressed a circular to a large number of the profession asking an expression of opinion on the points raised in his paper and inclosing a ballot for that purpose. He has now issued a circular giving the results of the ballot, and another ballot on a proposed compromise standard system. The following is an abstract of the more important parts of this circular.

The original ballot was sent to 253 engineers. Answers were received from all but 93. Of the 160 heard from, 20 had not the leisure to investigate the subject, 11 professed not to be posted on the question, 18 were opposed to balloting on such matters and 111 sent in ballots. The following table shows the branches of the profession represented in the ballots:

	Railway engineers. %	Bridge engineers. %
Not answering	54	43
Not having time	65	35
Not posted	82	18
Opposed to ballot	39	61
Balloting	42	47

In the latter class there were also 11% from other branches of the profession. The result of the ballot is given below:

Item No. 1.—19. In favor of adhering to the concentrated wheel load method of computing stresses, which is now in vogue.
16. In favor of adopting a constant car load per lineal foot, headed by a single locomotive excess load.
3 In favor of the latter, except that they specify two locomotive excess loads.
69. In favor of adopting the method of "Equivalent Uniform Loads," advocated by Mr. Waddell in his paper on "Some Disputed Points in Railway Bridge Designing."

	In favor.	Not in favor.
Item No. 2.—Adopting a system of train loads similar to that proposed by Mr. Waddell modified by addition of certain heavy concentrations for short spans	75	16
Increasing wheel loads for tenders	32	32
Increasing lengths of engines as their weights increase	15	41
Increasing loads on engine axles	16	45
Addition of train loads for mountain lines in which the engine loads shall be heavy and the car loads light	10	57
Having made, at expense of private parties or U. S. government experiments to ascertain dynamic effects of live loads applied at various speeds on bridge members of all kinds	108	0
Having made, at same expense, tests of full-sized members of steel bridges, especially compression members	106	2
The *ultimate* adoption of standard specifications for bridge designing which shall specify clearly and concisely, in every particular, such matters as loads, intensities of working stresses, quality of materials, workmanship, etc., but at the same time shall not infringe upon the individuality of the designer	98	6

Note.—For the system of train loads proposed by Mr. Waddell see "Transactions" Am. Soc. C. E., Vol. xxvi., Plate xvi., et seq., or Eng. News, Dec. 12, 1891.

From the preceding answers Mr. Waddell draws the following conclusions in regard to the present status of opinion on the questions discussed in his paper:

Item No. 1.—Of those who voted on this question about 18% are in favor of adhering to the concentrated wheel load method, and 82% are in favor of abandoning it. And of the latter about 22% are in favor of substituting a uniform car load headed by one or two engine excesses, and 78% are in favor of adopting the "Equivalent Uniform Load" method. This indicates very clearly that a large majority of American engineers interested in the subject are in favor of abandoning entirely (except, perhaps, for ascertaining stresses in existing structures) the burdensome method of computing stresses by the use of concentrated load, and substituting therefor the much simpler method of "Equivalent Uniform Loads." As soon as a set of live loads for railroad bridges is decided upon by the engineering profession I shall, with the shortest possible delay, prepare diagrams of end shears and equivalent loads, and distribute the same to all engineers interested.

Item No. 2.—It appears that my proposed system of train loads has met with general approval, but that certain changes therein are advisable. Opinion appears to be pretty equally divided as to whether the proposed loads on axles of tenders should be increased. The increase recommended in weight on one axle varies from 1,000 lbs. to 4,000 lbs., average being about 2,400 lbs. One gentleman made a very good suggestion, viz., that the weight per foot of the tender should not be less than that of the cars. If this suggestion were adopted the increase would vary from 2,300 lbs. to 3,000 lbs. per axle, the average being about 2,600 lbs. From letters received from several of the gentlemen who balloted, I am convinced that my weights on tender axles are too light; consequently I have determined to increase each of them by 3,000 lbs., leaving the weights on the leading wheels of the locomotives unchanged.

The wheel spacing adopted appears to be satisfactory to the most of those who balloted, although perhaps causing a small error on the side of safety.

Although the general opinion is that my proposed loads on main axles of engines are heavy enough, nevertheless I consider it better to increase each one by 1,000 lbs.

The question as to whether special loads with lighter cars are advisable for mountain lines seems to be settled conclusively in the negative.

It will be seen from the foregoing that the main question of retaining or abandoning the "concentrated load system" of calculating bridge strains has a very large majority in favor of abandoning the system. We believe this to voice the opinion of the profession in general. The ballot accompanying the circular we do not reprint, since most engineers interested will probably receive one. Those who do not can obtain it by addressing Mr. J. A. L. Waddell, Keith & Perry Building, Kansas City, Mo., which we strongly advise all to do.

SEWAGE PURIFICATION IN AMERICA.

(Continued from page 332.)

Canton, O.

The eighth chemical precipitation plant in this country for the purification of the sewage of a municipality was recently put in operation at Canton, O. Outside of Massachusetts, New York and New Jersey, this is the only municipal chemical precipitation plant in the United States.

The steps which led up to the adoption of sewage purification at Canton began in 1880, but the construction of sanitary sewers was not begun until 1888, and of the disposal works until 1892. The population of Canton in 1880 was 12,258 and in 1892 it was 26,189. The city built water-works in 1869.

The purification works as completed in the spring of 1893, and described below, are designed to purify the sewage by means of chemical precipitation, making use of lime and sulphate of alumina for precipitants and employing continuous settling tanks.

The works are located near Nimishillen Creek, in the northeast part of the 28-acre tract of land bought by the city in 1888.

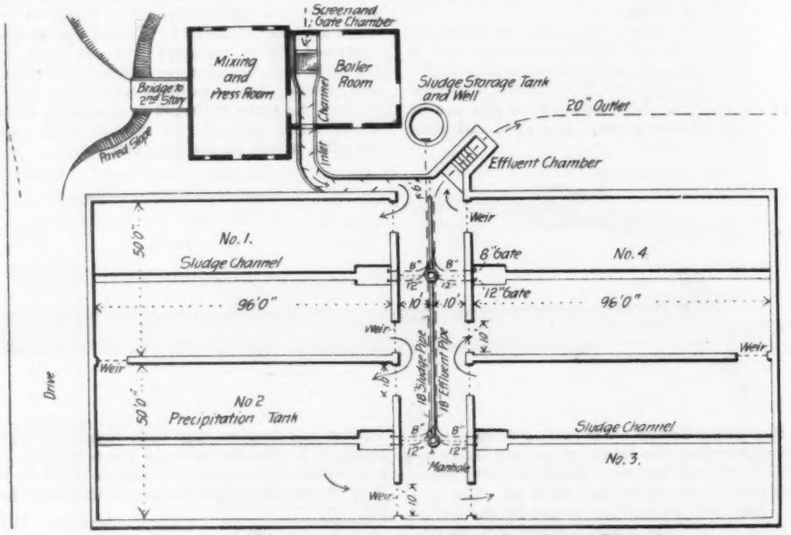


Fig. 80. PLAN OF SEWAGE PURIFICATION PLANT, CANTON, O.

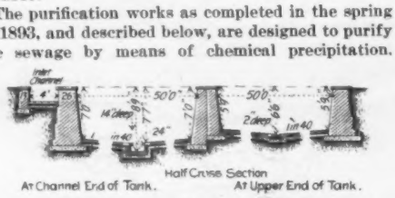


Fig. 81. Cross Sections of Tanks.

The outlet sewer discharges into a screen and gate chamber located beneath the floor of the boiler room, as shown in the plan of the disposal works, Fig. 80. This chamber is 8½ ft. wide, 14 ft. long, 3 ft. deep and is divided longitudinally into two compartments. In each compartment there is an iron screen and also sliding gates to regulate the flow of the sewage.

The gate chamber narrows, as shown on the plan, Fig. 80, to a width of 4 ft., from which it continues as the inlet channel, which is provided with baffle plates to aid in thoroughly mixing the chemicals with sewage. Both the combined screen and gate chamber and the inlet channel have side walls of 12-in. brick masonry resting on an 8×20-in. brick footing course. The floor of the inlet channel has a pavement of brick on edge in Portland cement laid in 1 in. of sand spread on a 5-in. concrete foundation.

There are four settling tanks, each 50×96 ft. inside, with walls from 5.75 to 7.58 ft. high above the bottom pavement. The walls between each pair of tanks are 28 ins. thick just below the coping and all the other walls are 26 ins. thick. By offsets on the outer and a batter of 1½ ins. to the foot on the inner side, the walls increase to a thickness of from 44 to 48 ins. at the footing courses, the latter in all cases being 8 ins. deep and 60 ins. wide. These walls are of hard burned shale sewer brick laid in Buckeye Portland cement mortar, one part cement and three parts coarse sand. The copings are of sawed Berea sandstone with quarry face edges and are 4 ins. thick.

Each tank slopes 1 in 40 to the front and from the sides to the central sludge channel, shown in Figs. 80, 81 and 82. The sludge channels increase from a depth of 2 ins. at the upper end to 14 ins. at the lower end (see Fig. 81), where they connect with the branches leading to the main sludge pipe and sludge well. The tanks are paved with hard burned shale paving brick on a foundation like that of the screen chamber. This pavement was grouted with Portland cement so that its surface is quite smooth. All the brick masonry was thoroughly cleaned of loose mortar and covered with three coats of Portland cement wash, which withstood the past winter without scaling.

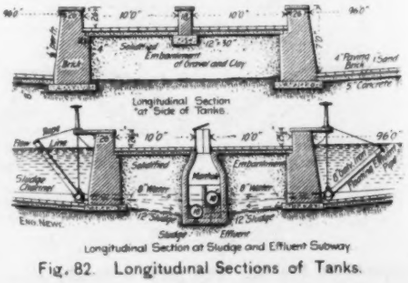


Fig. 82. Longitudinal Sections of Tanks.

Normally, as it appears from the information at hand, the sewage flows through the four tanks, as indicated by the arrows in the plan, Fig. 80, and finally falls over the steps shown in the effluent chamber and into and through the 20-in. effluent pipe leading to Nimshillen Creek. The effluent chamber is 5 ft. wide and 12 ft. long, of brick masonry, with steps of sawed Berea sandstone built into the side walls.

When one set of tanks is to be emptied, by closing the proper weirs the sewage can be diverted to the other two. The clarified sewage is drawn down to the level of the accumulated sludge by means of galvanized iron floating skimmer pipes, 8 ins. in diameter, 8 ft. long, connected with the 8-in. branch effluent drains by means of a swing joint and two elbows. Each branch effluent pipe is provided with an 8-in. lift valve, which, with the skimmer pipe, may be operated from a platform overhanging the wall of the tank, all as is shown in the section, Fig. 82.

The 8-in. branch effluent pipes connect with an 18-in. main pipe laid in the effluent and sludge subway, a cross-section of which is shown in Fig. 82. The main effluent pipe discharges under the steps in the effluent chamber. The sludge subway, it may be added, is beneath the central wall in the channel between the two pairs of tanks.

The main sludge pipe in the subway is 2 ft. below the effluent pipe and 18 ins. in diameter and has 12-in. branches, controlled by valves, leading from each tank. The sludge pipe extends to a sludge pump well, shown in plan in Fig. 80. This well has 16-in. brick walls and bottom, is 10 ft. in diameter, 18 ft. deep and has a capacity of 700 cu. ft. to its flow line. There is an 18-in. sluice gate at the sludge well with handwheel and standard operated from above.

The sludge and effluent pipes in the subway can be inspected at any time through the two manholes shown in the plan, Fig. 80, and the section, Fig. 82.

Further details of the works, including a description of the chemical mixers and sludge compressing apparatus, will be given in a later issue, as will a sketch of the early history of the project for a sewerage system with a reference to the various engineers connected with it.

Mr. L. E. Chapin, City Civil Engineer, was the engineer for the works, Mr. Samuel M. Gray, M. Am. Soc. C. E., having recommended chemical precipitation in 1888, but not having submitted plans. Mr. Wm. Dannemillier is president, and Mr. Josiah Hartzell is clerk of the board of sewer commissioners.

COST OF SEWER CONSTRUCTION AND MAINTENANCE AT ST. LOUIS, MO.

The total cost and cost per foot of the different sizes of sewers built in St. Louis during the fiscal year 1891-2 is given in the report of Mr. R. B. Southard, Sewer Commissioner, as follows:

Size and material of sewer.	Length in ft.	Cost. Total, $.	Cost. Av. per lin. ft., $.
4×5-ft., brick	182	647	3.56
3×4-ft., brick	3,295	10,019	3.04
2½×3½-ft., brick	1,394	4,517	3.24
2×3-ft., and 2½-ft. r'd, brick.	6,250	19,178	3.07
24-in. pipe	1,556	3,180	2.04
21-in. pipe	2,332	2,935	1.26
18-in. pipe	8,893	9,867	1.11
15-in. pipe	21,021	16,760	0.80
12-in. pipe	18,752	12,085	0.64
Total	63,675	79,188	....

The cost of inlets, manholes and other accessories in connection with the above 63,675 ft. of sewers, and the total cost of the sewers and accessories, was as follows:

	Cost. Total, $.	Cost. Average, $.
243 inlets	11,220	46.17
47 manholes on brick sewers	1,586	33.74
238 manholes on pipe sewers	10,758	45.20
Junctions, lumber, etc.	3,139	....
Cost of sewers as above	79,188	....
Total cost of sewers and accessories	105,891	....

To April 11, 1892, there had been built in St. Louis 375 miles of sewers at a total cost of $7,628,383. The total cost of maintenance, combined with the current expenses of the sewerage system up to April 11, 1892, was $1,182,697.

Mr. B. H. Colby was first assistant to the sewer commissioner at the time the report was made.

BUILDING ORDINANCES OF THE CITY OF CHICAGO.

These ordinances are the outcome of a most extended and searching investigation into the conditions now prevailing in Chicago—conditions brought about by the enormous structures of late years, which, by their design and the great loads imposed, made a radical change necessary in the former ordinances. The engineering features of the ordinances adopted March 13, 1893, are necessarily prominent and seem to have been well considered. The principal and most interesting structural points in the document may be abstracted, as follows:

Buildings within the fire limits are divided into the following classes: Class 1: Buildings devoted to the sale, storage or manufacture of merchandise, and stables. Class 2: Residences for three or more families, hotels, boarding or lodging houses occupied by 25 or more persons, and office buildings. Class 3: Residences for one on two families, or for less than 25 persons. Class 4: Buildings used as assembly halls for large gatherings of people. In describing the construction of buildings belonging to the above classes the ensuing definitions of terms shall govern:

The term "fireproof construction" applies to buildings in which all parts that carry weights, stairs, elevator inclosures and their contents, are made of incombustible material, and in which all metallic structural members are protected against the effects of fire by coverings of an incombustible and slow heat-conducting material. As such will be considered brick, hollow tiles or burnt clay, porous terra-cotta and two layers of plastering on metal lath.

In "skeleton construction" all external and internal loads and strains are transmitted from the top of the building to the foundations by a skeleton or framework of metal. In columns of rolled iron or steel, the different parts shall be riveted to each other, and shall be united by riveted connections to the beams and girders resting upon them. In cast iron columns, each successive column shall be bolted to the one below it by at least three ⅞-in. bolts, and the beams and girders shall be bolted to the columns.

The term "slow-burning construction" comprises all buildings in which the structural members are made wholly or in part of combustible material, but throughout which all materials shall be protected against injury from fire by coverings of incombustible, iron heat-conducting materials similar to those described above. Oak posts of greater sectional area than 100 sq. ins. need not have special fireproof covering. The expression, "mill construction" applies to buildings in which all the girders and joists supporting floors and roof have a sectional area of not less than 72 sq. ins., and above the joists of which there is laid a solid timber floor not less than 3¼ ins. thick. Wooden posts in buildings of this class are to have an area of at least 100 sq. ins. Iron columns, girders or beams must be protected as provided for fireproof buildings, but the wooden posts, girders and joists need not be covered. By the term "ordinary construction" is meant the ordinary system of construction, in which timber and iron structural parts are not protected with fire-resisting coverings.

Buildings of classes 1 to 3 shall be made entirely of fireproof construction if 100 ft. or more high, and entirely of slow-burning or of mill construction, if between 60 and 100 ft. in height. They may be built of ordinary construction if under 60 ft. Buildings of class 4, containing not more than 600 seats, may be built of ordinary construction. They shall be built of slow-burning or of mill construction, if they seat between 600 and 1,500 persons, and entirely of fireproof construction if containing more than 1,500 seats. If movable scenery is used in buildings of class 4, they shall be of slow-burning or of mill construction if they seat less than 1,000 persons, and must be entirely fireproof if they contain more than 1,000 seats.

No building shall be erected of greater height than 130 ft. from the sidewalk level to the highest point of external bearing walls. The height of no building of skeleton construction shall be more than three times, and of no isolated building of masonry construction more than four times its least horizontal dimension.

Loads.—Buildings of class 1 shall be designed for a minimum load of 150 lbs. for each sq. ft. of floor surface. For buildings of the classes 2 to 4, a live load of 70 lbs. per sq. ft. shall be assumed in addition to all permanent loads. In determining the strength of posts and the area of foundation for many-storied buildings of classes 2, 3 and 4, allowances are to be made for the fact that the before-mentioned live load of 70 lbs. per sq. ft. is but an occasional load, which rarely occurs simultaneously upon corresponding parts of many floors, and, if so, for a very brief period only.

Foundations shall be constructed of either of the following: Cement, concrete, dimension or rubble stones, sewer or paving bricks, timber piles covered with grillage of oak timber or an oak grillage may be used, all timber to be below city datum, however. Rails or beams used as parts of foundations must be thoroughly imbedded in concrete, and around the exposed external surfaces of such concrete foundations there must be a coating of cement mortar at least 1 in. thick. In pile foundations the piles shall be driven to reach the underlying stratum of hard clay or rock, and shall not be loaded with more than 25 tons. In other but pile foundations the limits of loads for different kinds of soil are to be the following: 3,500 lbs. per sq. ft., if the soil is a layer of pure clay at least 15 ft. thick without admixture of any foreign substance excepting gravel; 4,000 lbs. per sq. ft. if the soil is a layer of dry sand 15 ft. or more in thickness and without admixture of clay, loam or other foreign substance; 3,000 lbs. per sq. ft. if the soil is a mixture of clay and sand.

The offsets of foundations of concrete alone shall not exceed one-half the height of the respective courses, and such concrete foundations must not be loaded more than 8,000 lbs. per sq. ft. If reinforced by rails or beams, the offsets must be so adjusted that the fiber strain per sq. in. shall not exceed 12,000 lbs. for iron or 16,000 lbs. for steel.

Dimension stones must have uniform beds, and the offsets of layers must not be more than three-quarters of the height of the individual stones. The load per sq. ft. in foundation piers of dimension stones shall not be more than 10,000 lbs. In brick piers there shall be at every offset a bond stone at least 8 ins. thick and at the top of each pier a cap stone at least 10 ins. thick, or in all such cases a bond plate of cast or rolled iron. The extreme loads on brickwork laid in mortar of any cement, established as a standard cement by the Society of Civil Engineers of the Northwest, are 25,000 lbs. per sq. ft., and 18,000 lbs. for brickwork laid in ordinary cement mortar. The use of soft bricks for piers is prohibited.

Maximum Permissible Stresses.—Cast iron crushing stress for plates, 15,000 lbs. per sq. in.; for lintels, brackets or corbels, compression, 13,500 lbs. per sq. in., and tension, 3,000 lbs. per sq. in.; for girders, beams, corbels, brackets and trusses per sq. in., 16,000 lbs. for steel and 12,000 lbs. for iron.

For plate girders:

$$\text{Flange area} = \frac{\text{Max. bending moment in ft.-lbs.}}{C\,D}$$

D = Distance between center of gravity of flanges in feet.

C = 13,500 for steel; 10,000 for iron.

$$\text{Web area} = \frac{\text{Max. shear}}{C}.\quad C = \begin{cases} 10{,}000 \text{ for steel.} \\ 6{,}000 \text{ for iron.} \end{cases}$$

For rivets in single shear per sq. in. of rivet area:

	Steel.	Iron.
If shop driven	9,000 lbs.	7,500 lbs.
If field driven	7,500 lbs.	6,000 lbs.

Maximum permissible loads:

For cast iron round columns:

$$S = \frac{10{,}000\ a}{1 + \frac{l^2}{600\ d^2}}$$

l = length of column in inches.
d = diameter of column in inches.
a = area of column in square inches.

For cast iron rectangular columns:

$$S = \frac{10{,}000\ a}{1 + \frac{l^2}{800\ d^2}}$$

"l" and "a" as before.
d = least horizontal dimension of column.

For riveted or other forms of wrought iron columns:

$$S = \frac{12{,}000\ a}{1 + \frac{l^2}{36{,}000\ r^2}}$$

"l" and "a" as before.
r = least radius of gyration in inches.

For riveted or other steel columns, if less than 60 r in length:

$$S = 17{,}000 - \frac{60\ l}{r}.$$ "l" and "r" as before.

If more than 60 r in length:

S = 13,500 a. "a" as before.

For wooden posts:

$$S = \frac{a\,c}{1 + \frac{l^2}{250\,d^2}}$$

a = area of post in square inches.
d = least side of retangular post in inches.
l = length of post in inches.
c = { 600 for white or Norway pine. 800 for oak. 900 for long leaf yellow pine.

For timber girders:

$$S = \frac{c\,b\,d^2}{l}$$

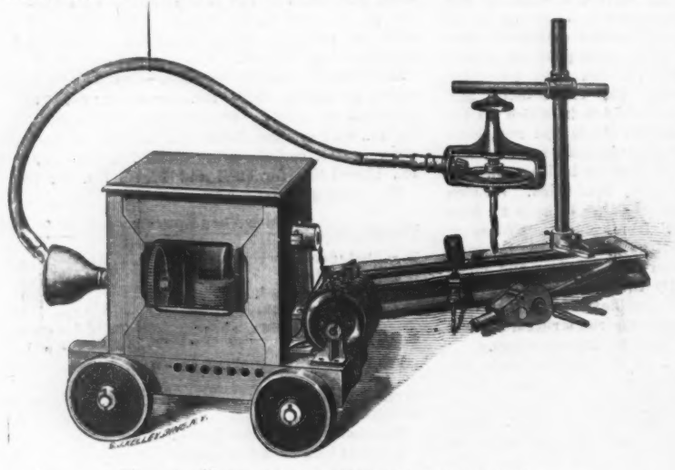
b = breadth of beam in inches.
d = depth of beam in inches.
l = length of beam in feet.
c = { 160 for long leaf yellow pine. 120 for oak. 100 for white or Norway pine.

Wind Bracing.—In all buildings the height of which is more than one and one-half times their least horizontal dimension, allowances shall be made for a wind pressure of not less than 30 lbs. for each sq. ft. of exposed surface. As factors of resistance to wind pressure may be counted: 1. Dead weight of structure, especially in its lower parts. 2. Diagonal braces. 3. Rigidity of constructions between vertical and horizontal members. 4. Construction of iron or steel columns in such manner as to pass through two stories with joints breaking in alternate stories.

Towers, domes and spires may be built on top of the roofs of buildings, classes 1, 2 and 3, but shall not occupy more than one-quarter of the street frontage of any building or have a base area of more than 1,600 sq. ft. If built to heights between 60 and 90 ft. above the sidewalk, they shall be of slow-burning and of fireproof construction if more than 90 ft. above the sidewalk. Where the area of such spire, dome or tower exceeds 100 sq. ft., its supports shall be carried down to the ground and shall be of slow-burning construction, if the supported structure is between 60 and 90 ft. high, and of fireproof construction if more than 90 ft. high.

A CONVENIENT PORTABLE DRILLING PLANT.

We illustrate herewith a convenient combination of a Stow flexible shaft with a portable electric motor, which has recently been brought out by the Stow Mfg. Co., of Binghamton, N. Y. The Stow flexible shaft has become well known and widely appreciated, but it is not always convenient



A CONVENIENT PORTABLE DRILLING PLANT.

to lead the driving rope to operate the shaft into every place where it is desired to use it. This difficulty is overcome by the plant illustrated, which is mounted on wheels and can be rolled to any part of the shop, the insulated wire being unreeled as the machine moves. The manifold uses of such a conveniently portable tool will readily suggest themselves. For tapping, drilling and reaming metal in boiler, tank and bridge shops, and for boring and driving screws and bolts in wood-working shops it will leave hand labor far out of sight, and lead to a great saving in expense.

The motor driving the machine has a normal speed of about 600 revolutions per minute which can be increased to 1,100 or 1,200, or reduced by gearing to 275 if desired. The motors are wound for either 110, 220 or 500 volts as ordered.

THE LASTING CHARACTER OF SOIL POLLUTION.

Dr. Lauciani, in his work on ancient Rome, says that while a system of garbage collection existed under Roman rule, the disposal of refuse was as crude as it is in many modern towns and cities. That this disposal method was regarded as a nuisance at a very early period is made evident by the fact that sanitary laws were passed 2,000 years ago that were intended to at least mitigate the trouble.

Some of these laws, graven on stone, were unearthed by Dr. Lauciani in his excavations, and the text of one of them reads, "C. Centius, son of Caius the Praetor, by order of the Senate, has set up this line of terminal stones to mark the extent of ground that must be kept absolutely free from dirt, and from carcases, and from corpses. Here also the burning of corpses is strictly forbidden." On the bottom of this stone, in red letters, some probably near resident had written, "Do carry the flirt a little farther; otherwise you will be fined."

But this bounding line, beyond which any foul matter might be cast to putrify under a Roman sun, was only 400 ft. from the city walls as erected by Servius Tullius. When Dr. Lauciani dug up these stones, on June 25, 1884, and about 2,000 years after the use of this area for refuse disposal, the soil was still so polluted and the stench arising from it so horrible that even his workmen, inured to such work as they were, found it absolutely unbearable and had to be relieved at frequent intervals.

The dumping ground near the Esquiline Cemetery, including the present cemetery itself, was the greatest of these nuisances, and so long ago as the beginning of our Christian era the Roman rulers found it necessary to cover this area with 25 ft. of soil and to convert it into a garden.

The long and active survival of disease germs in soil was also claimed in excavations made inside a cofferdam uncovering the bed of the Tiber alongside the bridge leading to the Castle of St. Angelo, in Rome. Here, in successive strata, were found coin and other relics fixing the age of the deposit down to the fourth century A. D. The soil as it was slowly removed was piled upon an adjoining wharf and then taken away. When the very lowest and oldest of all the strata disturbed was so disposed of, an epedemic of typhoid fever broke out among the workmen and those living in the immediate vicinity. The result of careful examination is said to have shown that the trouble came from this lowest strata, and that disease germs that had been lying dormant at the bottom of the Tiber for nearly 1,500 years were still active for evil and proved their vitality. This statement, as far as the survival of the germs of typhoid are concerned, has been disputed. Considering the difficulty of detecting these germs in refuse recently deposited, there is ample room for doubt as to the exact point in the strata that caused the trouble observed.

CARPENTER STEEL PROJECTILES.

The Carpenter Steel Co., of Reading, Pa., advises the "Bulletin" of the American Steel and Iron Association that the projectiles made by it for the United States government are cast in molds double the size of the finished shell. They are then hammered into shape in dies and machined, after which they are hardened by secret processes to proper temper and finally finished to exact dimensions, plugs being fitted in to fill the bored-out base of the chamber. If the shells are then truly concentric and balanced, two of each lot are fired at a hardened plate made of open-hearth steel; this plate, which is backed by 3 ft. of live oak backing, being 1¼ times the thickness of the shell fired. If the shell penetrates the plate and backing without suffering injury the lot from which it is selected is accepted. The two shells selected for trial must be those which in the opinion of the inspecting officer are least likely to stand the test. The company has furnished over 40 lots of shells to the government without a single one being rejected. During 1892 alone it manufactured for the government about 1,200 tons of steel armor-piercing projectiles.

The steel used by the company in making projectiles is a special grade of chrome steel, and is of high tensile quality, the testpieces frequently averaging 110 tons per sq. in., the elongation being about 7%. In addition to manufacturing shells the company also produces forgings for the mechanism of guns, etc., for the government. It also manufactures for the trade a special grade of air-hardening and carbon steel for tools, cutlery, dies, springs, etc.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

BEECH CREEK.—The contract for the construction of a branch into Lock Haven, Pa., has been awarded to Geo. S. Good & Co., the city having raised the required $25,000.

CINCINNATI, HAMILTON & DAYTON.—This road is preparing to build a third track between Cincinnati and Dayton. The work of widening the roadbed has been in progress about a year, and it is reported that the additional track will soon be laid.

CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS.—This road is laying a double track between Cincinnati and Dayton. The issue of $5,000,000 of bonds for improvements and new equipment has been approved.

PENNSYLVANIA.—The Cherrytree branch of the Cambria & Clearfield road has been opened. The new line extends from Cherrytree, Indiana Co., Pa., to the main line at Cresson, 30 miles, and opens up a valuable coal and lumber region.

PHILADELPHIA & SEASHORE.—This road has been purchased by a syndicate, headed by Logan M. Bullitt. It extends from Winslow Junction to Sea Isle City, N. J., and part of the grading has been done on a branch from Tuckahoe Junction to Cape May, where valuable terminal ground has been secured. It is proposed to complete this branch.

SOUTH MOUNTAIN.—The project of building this road to extend from the Delaware River, at or near Portland, Northampton Co., Pa., to the Susquehanna River, above Harrisburg, is being revised.

STATEN ISLAND RAPID TRANSIT.—The road will issue $500,000 of 4½% gold bonds for improvement purposes.

TOLEDO & OHIO CENTRAL.—It is reported that construction trains will be running between Ridgeway and Columbus by July 1, and passenger trains in August. Rails are now being laid at Ridgeway, and the grading has been completed for nearly 20 miles.

UNADILLA VALLEY.—It is reported that the local subscription required to complete this road between Leonardsville and New Berlin, N. Y., has not yet been secured.

WOONSOCKET & PASCOAG.—This road is about completed between Pascoag, R. I., and East Thompson, Conn., 8 miles.

Southern.—Existing Roads.

KANAWHA & MICHIGAN.—The extension of this road to Kanawha Falls, W. Va., is nearing completion. The roadbed is done, and rails have been laid about to Cannelton.

MOBILE & OHIO.—The holders of the mortgage bonds of this road have approved the proposed extension to Montgomery, Ala.

RALEIGH & WESTERN.—The right of way for this road, between Egypt and Ashboro, N. C., 45 miles, has been nearly all secured, and it is reported that the route will be definitely located within a few days.

TALLAHASSEE, CARRABELLA & GEORGIA.—The contract for the completion of this road between Carrabella and Tallahassee, Fla., has been awarded to McIntyre & Davidson. It is proposed to extend the line to Thomasville, Ga.

Northwest.—Existing Roads.

DES MOINES & FORT DODGE.—The preliminary survey has been completed for this line between Ruthven, Ia., and Jackson, Minn., 32 miles. The road will be constructed this summer if sufficient aid is voted.

Projects and Surveys.

BISMARK & GALVESTON.—The Populists of Kansas and Nebraska are holding mass meetings to further the building of a road from Bismark, N. Dak., to Galveston, Tex., to be owned by the several states through which it would pass.

CENTRAL TERMINAL RY. CO.—Incorporated at Chicago; $25,000; Wm. P. Sidley, Chas. H. Hamill, W. J. Louderback, A. D. White and others.

WAUKESHA & BEAVER DAM.—Chas. J. Hustis, Hustisford, Wis., has been elected director, with authority to secure the construction of this road, if pos-

sible. It is said that if $600,000 of stock is taken by citizens along the route the road will be built at once.

Southwest.—Existing Roads.

CHOCTAW COAL & RY. CO.—Plans have been completed for the completion of this road, and it is reported that the work will be resumed in September, and the line between South McAlester and Oklahoma City completed before February, 1894.

KANSAS CITY, PITTSBURG & GULF.—This road was completed May 18 to Pittsburg, Kan., from Cambria, 31 miles. Considerable grading has been done between Pittsburg and Joplin, Mo., and this line is expected to be soon completed.

SOUTH GALVESTON & GULF SHORE.—This company has filed resolutions authorizing the issue of $375,000 second mortgage bonds for construction and equipment.

TEXAS CENTRAL.—This company has filed an amended charter, authorizing an extension of the line from Albany, Shackelford Co., northward to the New Mexico state line; also a branch from Waco, through Erath Co., to the Texas & Pacific in Palo Pinto Co.

Projects and Surveys.

GULF, BEAUMONT & KANSAS CITY.—Bids were received by John H. Kirby, Vice-Pres., Houston, Tex., May 18, for constructing this road from Beaumont, Tex., northward. The survey has been completed from Beaumont to Jasper, and the permanent survey from Beaumont to Pine Island, 10 miles, and will be continued across the Natchez River, through Jasper Co., to its northern border. The road will be 75 miles long, and the construction will commence at once.

Rocky Mt. and Pacific.—Existing Roads.

KASLO & SLOCAN.—This road is to extend from Kaslo, B. C., on Kootenai Lake, west to the Slocan mines, about 30 miles, and the work on the first 20 miles will be commenced at Kaslo at once. Bids for clearing the first section were opened May 22. D. J. Munn., Victoria, and J. Hendry, New Westminster, B. C., are the projectors of the road.

COLUMBIA & PUGET SOUND.—It is reported that this road will be changed to broad gage, and that surveys are being made for an extension of the line to connect with the Northern Pacific, near Palmer, Wash.

PECOS, WASH.—Murray Harris, Ch. Engr., and his assistants have completed the survey of this road from Eddy to Roswell, N. Mex. The construction will be commenced in a few days.

SOUTHERN PACIFIC.—It is reported that this road will soon be extended from Phoenix to Prescott, Ariz., 110 miles. The line was surveyed over a year ago.

WASHINGTON SOUTHERN.—Col. C. M. Sheafer, receiver of this road, has been directed to build the Goldsborough cutoff, 4.6 miles long, and all but 8,000 ft. will be built by the Grainger Lumber Co.

Projects and Surveys.

CALGARY & KNEE HILL.—It is reported that work on this road will be commenced in a short time. It will extend from Calgary, N. W. Ter., northeast to the mining region of Knee Hill, about 60 miles.

DENVER, SALT LAKE & SAN FRANCISCO.—The chamber of commerce, Denver, has recommended that a company be organized to build this road. Local capitalists are reported as interested in the project.

LOS ANGELES, OWENS VALLEY & UTAH.—It is reported that the contract for the construction of this road from Mojave, Cal., to Independence, Cal., 150 miles, has been awarded to F. E. Green, Los Angeles. The road is to be completed in nine months, the cost to be about $1,500,000.

SAN DIEGO & PHOENIX.—It is reported that $400,000 of preferred stock will be sold to prosecute the survey for this road. If sufficient money is raised a grading force will be put on.

STREET RAILWAYS.

ROCHESTER, N. Y.—The Rochester & Irondequoit Ry. Co. will build a road to Windsor Beach; capital stock, $1,000,000.

MOUNT PLEASANT, PA.—Incorporated, Mt. Pleasant & Hammondsville Electric St. Ry. Co.; $18,000; Pres., D. P. Lane.

PHILADELPHIA, PA.—Incorporated, Shenandoah & Mahony City St. Ry. Co.; $100,000; Pres., J. F. Bailey, 750 North 20th St.

TOWANDA, PA.—Incorporated, Towanda Traction Co.; $42,000; Pres., Geo. W. Kipp, Kingston.

GOSHEN, IND.—The first spike of the Goshen & Elkhart Electric Ry. was driven May 20. The company will also furnish electric lighting and power to manufacturing establishments, and business houses.

FAIRBURY, ILL.—A city council has voted a franchise to the Chicago & St. Louis Electric R. R. Co., to use numerous streets in the city to operate street cars. The main line of this road will pass through the western portion of the city, and the company will locate a power house here, the city paying $10,000 when the road is completed.

HANNIBAL, MO.—A fund has been raised to make a preliminary survey for an electric line from this city to Palmyra. Work will begin at once, a special committee having been appointed to superintend the survey.

DENVER, COLO.—The Pleasure Resort Ry. Co. has been incorporated to build an electric line to North Denver, and to Rocky Mountain and Berkeley lakes; capital stock, $100,000.—The city council is considering awarding an additional franchise to the City Park Ry. Co.

HIGHWAYS.

NEW YORK.—The contract for constructing roads at reservior M. in North Salem, Westchester county, has been awarded by the aqueduct commissioners, New York, to John Twiname at $64,530.

GEORGIA.—The commissioners of Ribb county are considering a proposition to issue bonds for $40,000 for road improvements.

OHIO.—The citizens of Cranberry township have voted to issue bonds to improve the town roads.

OREGON.—Plans are being made for a road from Baker City to Eagle Valley, about 33 miles. C. J. Johns and E. H. Mix, Baker City, are interested.

BRIDGES.

CAMBRIDGE, MASS.—The following bids were received May 23 for the Fresh Pond Ave. bridge, and the contract awarded to the Massillon Bridge Co.:

New Jersey Steel & Iron Co.	$7,325
Toledo Bridge Co.	7,250
Berlin Iron Bridge Co.	7,140
Canton Bridge Co.	6,900
Penn Bridge Co.	6,355
R. F. Hawkins	6,778
Massillon Bridge Co.	4,800

WOONSOCKET, R. I.—The city has voted to build an iron bridge from Main St. across the Blackstone River to Hamlet Ave. Estimated cost, $100,000.

BUFFALO, N. Y.—Plans are being prepared and bids will be soon asked for constructing an iron bridge over Scajaquada Creek.

MACON, GA.—The county commissioners talk of calling an election to vote on an issue of $100,000 of bonds for public improvements. About $40,000 will be for a bridge over the Ocmulgee River.

GAINESVILLE, TEX.—Bids will be received until June 6 for building a wire suspension bridge across Pecan Creek. H. E. Shoppmeyer.

WATER-WORKS.

NEWPORT, ME.—The town has voted to contract with the Newport Water Co. for 15 hydrants and two water tanks for five years, at $400 per year. This is reported to insure the construction of the works.

MANCHESTER, N. H.—The city council has voted to issue bonds for $300,000 for extensions and new works. A contract has been awarded to Henry R. Worthington, New York, for two 3,000,000-gallon high duty pumping engines.

RUTLAND, VT.—Plans have been adopted for extensions, including 9,000 ft. of 12-in. pipe, 7,623 ft. of 8-in., 40,940 ft. of 6-in. and 30,000 ft. of 4-in. pipe. The work will be advertised at once.

BLACKSTONE, MASS.—A petition will be presented to the selectmen asking that the Woonsocket works be extended through this town.

MILLBURY, MASS.—A town meeting was held June 1 to see if the town would purchase the franchise of the Millbury Water Co., or would contract for a supply. The works have not been built.

DARIÉN, CONN.—The Darien Water Co. has been incorporated with a capital stock of $150,000. About 17 miles of pipe will be laid so as to supply Noroton and adjacent villages. Pres., Theophile Euphrat Darien; Vice-Pres., Wm. H. Morton, New York; Secy., Joseph B. Rider, New York; Treas., Wm. B. Rider, South Norwalk.

DOLGEVILLE, N. Y.—The town has voted in favor of works.

FRANKFORT, N. Y.—The committee reports that works will cost about $50,000. It is reported that they will be put in.

JAMESTOWN, N. Y.—The board of public works has recommended that the city build works; estimated cost $250,000. A private company built works here in 1882.

OGDENSBURG, N. Y.—The commissioners have granted the Morrison, Allen Filter Co., New York, permission to put in a filter plant as an experiment; capacity 125,000 gallons per day.

DECKERTOWN, N. J.—C. H. Smith, Middletown, N. Y., has been engaged to secure a supply. The citizens are reported as undecided whether to grant a franchise or to build works.

BRADFORD, PA.—The commissioners will receive bids until June 5 for 23,800 ft. of 16-in. cast iron pipe, 12,350 ft. of 8 to 4-in. pipe, 12,000 lbs. of special castings, hydrants, gates, etc.; also for trenching and laying pipe; also for constructing a 60,000,000-gallon reservoir.

COCHRANTON, PA.—Bids are asked until June 10 for works including about 4.5 miles of pipe and a 200,000-gallon reservoir. C. A. Miller, Burgess.

CORAOPOLIS, PA.—New pumps and pipes will be purchased, to cost $20,000.

BERKLEY, VA.—Chas. Bliven is interested in proposed works. The present plant consists of 30 wells, having a daily capacity of 1,000,000 gallons. The proposed plant will have 60 additional wells, compound condensing pumps and a 20×125-ft. standpipe.

FARMVILLE, VA.—A 15-year franchise for works has been granted to Dunny & Rawn, Roanoke.

YORKVILLE, S. C.—It is reported that bonds will be issued for $16,000 for a supply.

ATLANTA, GA.—The citizens of West End will vote June 12 on an issue of bonds, a part of which will be used to extend the new works into that part of the city.

GREENVILLE, MISS.—Bids are asked until Aug. 1 for works. J. M. Lee, Cy. Clk.

JELLICO, TENN.—It is reported that the Jellico Water-Works Co., recently organized, will at once construct works. Pres., E. H. Utter; Secy., H. K. Tramelle; Treas., Robert Ross.

OBERLIN, O.—A contract has been awarded to John Berg for a 20 × 40-ft. stone tower, at $1,728, and to the Variety Iron Works, Cleveland, for an 18 × 35-ft. elevated steel stand-pipe, at $1,720. W. B. Gerrish, Corp. Engr.

WINTON PLACE, O.—It is reported that preliminary steps have been taken to secure a supply.

BAD AXE, MICH.—May 29 the citizens voted on the issue of bonds for $16,000 for works.

SOUTH MILWAUKEE, WIS.—The South Milwaukee Water Co. has been incorporated at White Water; capital stock, $1,000.

PIERSON, IA.—Works are being discussed.

LAKE BENTON, MINN.—The village council will sell bonds for $13,000 June 10 to construct works.

READS LANDING, MINN.—It is proposed to secure an artesian supply.

ST. PAUL, MINN.—The department of public works will receive bids until June 13 for 13,896 ft. of 10 to 4-in. cast iron pipe, water tower, pumping plant, etc.

ALLIANCE, NEB.—Bids are asked until June 21 for works to cost $17,000. A. A. Richardson, Consult. Engr., Lincoln.

FREMONT, NEB.—Bids are asked until June 12 for a 15 × 105-ft. stand-pipe. J. W. Andrews, Cy. Engr.

GORDON, NEB.—Bids will be received until June 15 for a complete system, including wells of 500,000 gallons daily capacity, 10 × 50-ft. stand-pipe, 2,601 ft. of 6-in. pipe, 500,000-gallon duplex pump, 40-HP. boiler, etc. Robert McCarty, Vil. Clk.

HIGGINSVILLE, MO.—The citizens have voted to issue bonds for $17,000 for works and an electric light plant.

CAMERON, TEX.—It is reported that the city council has voted to contract for works.

KAUFMAN, TEX.—It is reported that a proposition has been accepted for works.

CRIPPLE CREEK, COLO.—A franchise has been granted to the Michigan Pipe Co., Bay City, Mich. The plant will cost about $75,000 and be constructed at once. 85 hydrants being required. The supply will be obtained from West Beaver Creek.

NATIONAL CITY, CAL.—The San Diego Land & Town Co., which owns the works at this place, has refused to furnish water, it is reported, and a special committee has been appointed to investigate the subject. Ralph Granger and J. H. Kincaid are members of the committee.

OAKLAND, CAL.—W. J. Dingee is interested in a scheme to convey water to Oakland from three artesian wells near Alvarado, having a daily capacity of about 10,000,000 gallons. A 30-in. main would be built through Mount Eden, San Lorenzo, San Leandro, to this city, a distance of 18 miles.

SACRAMENTO, CAL.—The committee of ten recommends that bids be asked for an annual supply of 900,000,000 gallons, a franchise to be granted for 20 years.

COLVILLE, WASH.—The city clerk has been directed to advertise for propositions for a supply. It is reported that the council will grant a franchise for works and for electric lights.

GARFIELD, WASH.—The citizens have voted to issue bonds for $13,000 for works.

PUYALLUP, WASH.—The city council has voted in favor of new works. There has been talk of buying the present plant from the Tacoma Light & Water Co.

SALT LAKE CITY, UTAH.—It is reported that the superintendent advocates the placing of a filter, to cost $14,000, in the Parley Canon system.

TORONTO, ONT.—The Toronto Aqueduct Co. has made a proposition to introduce a supply from Lake Simcoe and Georgian Bay. A 65-mile ship canal from the bay to Lake Ontario is included in the scheme, alongside of which the water supply conduit would extend; the whole work estimated to cost $65,000,000.

ARTESIAN WELLS.

BUSHNELL, ILL.—Bids are asked until June 14 for ten 3-in. tubular wells, one 10-ft. well and one 4 × 8-ft. well, 120 ft. deep, as stated in our advertising columns. O. C. Hicks, Cy. Clk.

IRRIGATION.

CENTRAL POINT, ORE.—The Jackson County Flume & Irrigation Co. has been incorporated by H. M. Ball, W. E. Caul and E. G. Caul; capital stock, $1,000,000.

SEWERS.

ANDOVER, MASS.—C. E. Abbott, J. L. Smith and W. S. Junkins have been elected sewerage commissioners.

FAIRHAVEN, MASS.—T. N. Morse is a member of the committee having charge of the proposed system.

PLYMOUTH, MASS.—At a special town meeting May 23 the committee on sewerage reported recommending the plans for sewerage and drainage prepared by Charles F. Chase, C. E., Providence, R. I. The report was adopted and $20,000 appropriated to carry out the work.

WORCESTER, MASS.—Petitions have been filed for work to cost over $100,000. The appropriation is $30,000.

EAST PROVIDENCE, R. I.—The sewer contract has been awarded to David Z. Anthony, at $8,985, other bids being as follows: Bernard Swift, $12,112; Frederick E. Shaw, $11,188; Geo. R. Newman, $11,062; Daniel S. Peck, $10,537; F. A. Snow, $10,522.

BUFFALO, N. Y.—The following bids were received for a brick and tile sewer in Military Road: E. J. Green, $19,683; McGregor & Hughes, $19,880; Henry Harter, $19,998; W. A. Green, $20,430; G. T. Dark, $20,890; W. G. Smith, $21,400; Jacob Ritzman, $22,426; Wm. Franklin, $24,000; Thomas McKeown, $25,300.

MEDINA, N. Y.—Bids are asked until June 15 for a sewer to cost $16,000 to $20,000. Edward Posson, Clk. Sewer Bd.

NEW ROCHELLE, N. Y.—We are informed by J. K. Wilkes, Engr., that the contracts for sections 4 and 5 have been awarded to Molloy Bros., New Rochelle, at $26,759 and $15,682, respectively. J. R. Byron, Mount Vernon, bid $28,615 and $15,730, and Conover & Newton, Orange, N. Y., $37,972 and $19,716, and the following bid only for section 4: F. A. & C. B. Cadwell, New Britain, Conn. $28,453; Patrick Fox, New Rochelle, $29,381; Daniel Murray, Port Chester, $34,181.

WASHINGTON, D. C.—The district commissioners will receive bids until June 7 for constructing sewers.

NEWPORT NEWS, VA.—It is reported that a system will be put in soon.

HUNTINGTON, W. VA.—W. E. Williams, Surv. Cabell Co., informs us that the city expects soon to vote on the issue of sewer bonds for $50,000.

MOBILE, ALA.—J. J. Deery, New York, and L. H. Woodrop, Philadelphia, representing the National Sewerage & Sewage Utilization Co., New York, have been requested to submit plans and propositions for a system.

GREENVILLE, MISS.—A system is proposed. Address J. M. Lee, Cy. Clk.

MEMPHIS, TENN.—Additional work has been ordered, including 10,349 lin. ft. estimated to cost $8,279.

OBERLIN, O.—W. B. Gerrish, Corp. Engr., informs us that there will be about six miles of district sewers to let early in July.

PORTSMOUTH, O.—P. Kelley has been awarded a contract for a sewer in ward 6, at about $35,000.

SPRINGFIELD, O.—Clifton M. Nichols, Secy. Bd. of Trade, writes us that the city has appropriated $10,000 for experimenting. One intercepting sewer is proposed; also a complete separate system.

ALTON, ILL.—Bids are asked until June 12 for a pipe sewer in two streets. J. J. Brenholt, Mayor.

DES MOINES, IA.—Plans are being considered for a system for the East Side; size, 48-in. double ring brick to 12-in. pipe. A contract for 14 miles of sewers to drain the west and northwest part of the city has been awarded to Bryan & Youngerman, at about $132,000.

FREMONT, NEB.—Contracts will be awarded for 11 miles of 18 to 8-in. pipe sewers, average cut 8 ft., estimated to cost $45,000, as soon as 5% 20-yr. bonds are sold. Andrews & Burrell, Cy. Engrs.

INDEPENDENCE, MO.—The Independence Improvement Assn. has voted to ascertain the cost of a survey of the city for a system. J. H. Taylor and Geo. Gates are interested.

FORT WORTH, TEX.—The contract for a system has been awarded to F. E. Alexander & Co., of this city.

AUBURN, CAL.—The citizens voted May 20, almost unanimously, to issue bonds for $20,000 for a system.

OAKLAND, CAL.—Plans have been adopted for a sewer to drain the part of the city east and northeast of Lake Merritt; estimated cost, $111,000.

CONTRACT PRICES.

LOCK.—Florence, Ala.—We have received from Capt. Geo. W. Gaethals, U. S. Engineer Office, the itemized bids received for the construction of the lock for Colbert Shoals Canal, Tennessee River, Ala. (near Piverton, Ala.), noted in our issue of last week. The total bids were as follows: 1, Jere A. Clark, Quincy, Ill., $305,766; 2, Dunn, Laliande & Co., Birmingham, Ala., $320,118; 3, M. V. Henry, Birmingham, Ala., $343,342; 4, Shipman & Stewart, Cincinnati, $355,092; 5, Samuel Walton & Co., Roanoke, Va., $370,147; 6, Geo. T. Nellis, Leavenworth, Kan., $403,743; 7, Neeley & Smith, Chattanooga, Tenn., $440,350; 8, Christie & Lowe, Washington, $471,185; 9, Kirk & Miller, Madison, Ind., $569,251; 10, Petitdidier & Hoag, Cincinnati, $624,-634. All masonry and concrete is to be in Portland cement. The prices follow:

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Earth excavation, 97,480 cu. yds...	$.58	$.48	$.33⅓	$.70	$.60	$.80	$.75	$.85	$1.20	$1.75
Rock excav., 8,410 cu. yds.....	1.00	1.87	1.50	2.00	1.25	1.50	3.00	4.00	1.50	5.00
Concrete, 66 cu. yds.....	5.00	6.75	10.00	10.00	7.00	10.00	8.00	12.00	12.00	9.00
Rubble, 19,085 cu. yds.....	8.00	7.88	9.25	8.00	8.00	9.50	11.50	12.00	13.00	13.00
Fine pointed masonry, 2,974 cu yds.	12.00	16.00	18.00	20.00	22.00	19.25	17.00	16.25	19.50	19.00
Rough " " 392 cu. yds.	9.00	14.00	13.00	16.00	18.00	18.50	15.00	15.00	19.25	17.00
Rock-faced " 224 cu. yds.	8.50	11.75	12.00	16.00	15.00	18.50	13.00	15.00	19.00	15.00
Sills, 754 cu. yds.....	12.00	16.50	22.00	20.00	24.00	19.50	17.00	18.00	22.50	25.00
Granite quoins, 195 cu. yds.....	45.00	25.00	35.00	60.00	35.00	50.00	63.00	60.00	40.00	31.00
Coping for walls, 908 cu. yds.....	12.00	19.50	20.00	8.00	24.00	20.00	18.00	18.50	21.00	21.00
" " well walls, 17 cu. yds.	12.00	19.50	20.00	8.00	24.00	20.00	14.00	18.50	21.00	17.00
Arches, cut stone, 173 cu. yds.....	30.00	17.00	16.00	25.00	25.00	20.00	17.00	20.00	18.00	25.00
Brick, 27 cu. yds.....	12.00	9.50	15.00	25.00	18.00	15.00	13.00	21.00	20.00	19.00
Grooves, 1,400 sq. ft.....	.50	.50	.75	.50	4.00	.50	.50	.50	1.00	1.00
Earth filling, 16,932 cu. yds.....	.35	.27	.35	.02	.30	.25	.30	.50	.15	2.00
Stone filling, 1,488 cu. yds.....	.50	.37	.70	1.00	.35	4.00	3.50	3.00	.75	2.50
Paving, 367 sq. yds.....	3.00	2.00	2.50	2.00	4.00	1.00	1.50	3.00	1.10	3.00

STREETS.

PAWTUCKET, R. I.—The city council has voted to widen East Ave. to 60 ft., at an estimated cost of $100,000.

PELHAM MANOR, N. Y.—A contract for grading and macadamizing has been awarded to J. O. Merritt, Port Chester, and F. H. Merritt, White Plains, at about $40,000.

BELLEVILLE, N. J.—The township will receive bids until June 6 for macadamizing Cortlandt St.

TITUSVILLE, PA.—The city clerk will receive bids until June 5 for brick paving.

HUNTINGTON, W. VA.—Five squares of paving with vitrified brick will be done this season under last year's contract. The brick are laid in 2 ins. of sand upon 8 ins. of gravel. It is proposed to issue bonds for $25,000 for paving. L. W. Leete, Cy. Engr.

MONTGOMERY, ALA.—It is reported that the city will issue bonds for $250,000 for street and other improvements.

KNOXVILLE, TENN.—Bids are asked until June 8 for paving about 46,000 sq. yds. with brick. M. Nicholson, Cy. Engr.

FOSTORIA, O.—The city clerk will receive bids until June 12 for paving.

PLEASANT RIDGE, O.—Bids are asked until June 8 for macadamizing, flagging, etc., McGrew St. J. M. Harper, Engr.

WARREN, O.—The contract for paving about 19,000 sq. yds. with brick has been awarded to Davis & Caldwell, Youngstown.

FRANKFORT, IND.—The city clerk will receive bids until June 12 for grading, graveling, brick walks, etc.

SUPERIOR, WIS.—The board of public works is receiving bids for paving one street.

ST. LOUIS, MO.—The following contracts have been awarded: Macadam for one year.—G. Eyermann, Jr., $28,045; J. A. Lohrum, $6,360; St. Louis Stone Masons' Quarry & Building Ass'n, $21,000; Henry Ruckert, $12,-448; Bambrick-Bates Cons. Co., $19,960; Cavanagh Cons. Co., $19,200; E. Kinealy, $18,920; J. E. Perkinson, $12,000; Hill-O'Meara Cons. Co., $32,500; Fruin-Bambrick Cons. Co., $21,825; T. F. Hogan, $6,950. Hauling macadam from workhouse quarries.—Bertha Cook, $11,370. Screened gravel.—C. Morschel, $25,980. Red or cement gravel.—Pacific Red Gravel Co., $6,000; Watson Cons. Co., $25,475. New sidewalks and repairing old sidewalks with brick.—James Farrell, Jr., $16,-209. Sidewalks with artificial stone flagging and repairing sidewalks with brick.—H. G. Bohn, $3,927; J. C. Heman, $42,147. Repairing alleys, gutters, curbs and crosswalks.—J. A. Lohrum, $12,526; Fruin-Bambrick Cons. Co., $35,061; J. E. Perkinson and Thomas Hogan, $25,230.

ELECTRIC LIGHT AND POWER.

PAWTUCKET, R. I.—The lighting committee has been authorized to contract with the Pawtucket Gas Co. for street lighting lights of 1,200 c. p. to be used.

GAINESVILLE, FLA.—Jas. M. Graham desires estimates on an electric light plant, Edison incandescent and Thomson-Houston are systems.

CROWLEY, LA.—It is reported that a lighting plant will be operated in connection with the water-works. Address L. S. Scott.

NEWBURGH, O.—Bids will be received until June 21 for a lighting plant of not less than 1,000 incandescent 16-c. p. lights for the Cleveland Asylum for the Insane. H. C. Eyman, Secy. Bd.

OBERLIN, O.—The village has contracted with the Oberlin Gas & Electric Co. for 39 arc lights of 2,000 c. p. at $50 per light per year, each light to burn 1,500 hours.

KYLE, TEX.—Bids are wanted for an electric light plant; population, 5,000. D. W. Crosthwait.

NEW COMPANIES.—Beverly & Edgewater Park Electric Light & Power Co., Beverly, N. J.; $30,000; L. R. Hibberd, J. V. Rice, Jr., Edgewater Park.——Red Bank Electric Light & Power Co., Red Bank, N. J.; $50,000; W. E. Harrison, G. M. Lane, E. G. Harrison.——American Electric Heating Corp., Portland, Me.; $5,000,000.——Tioga Point Electric Light & Power Co., Athens, Pa.; $3,000; Treas., Geo. A. Kinney.——Electric Light & Power Co. of Sayre, Sayre, Pa.; $3,000; Treas., Geo. A. Kinney, Athens.——Allegheny Valley Heat, Light & Power Co., New Kensington, Pa.; $15,-000; Treas., John T. Reeves, Beaver Falls.——Centralia Light & Power Co., Centralia, Ill.; $31,000; consolidation of the gas and electric light companies; Seymour Andrews, F. Kohl, G. L. Pittinger.——Electrical Supply & Construction Co., Kansas City, Kan.; $10,000; W. S. Nelson, W. H. Campbell, J. F. Franklin.——Wyoming Electric Light & Power Co., Wyoming, Ill.; $15,000.——Spring Valley Electric Light Co., Peoria, Ill.; $25,000.

SEWERS.—Huntington, W. Va.—We are informed by W. E. Williams, Surv. of Cabell Co., that a contract has been awarded to H. C. Shump for a single ring brick sewer, 30x4 ins., average cut 41.7 ft., at $2.85 per lin. ft.

Marinette, Wis.—E. L. Shaw, Cy. Engr., informs us that the following bids were received for proposed sewers: Donald McLeod, Port Huron, Mich., section 1, $4,610; 2, $39,650; 3, $9,183; W. M. Campbell, Menominee, Mich., $4,307, $46,225, $13,074; O. G. Kringle, Dubuque, Ia., $5,300, $40,875, $10,204; Andrew Anderson, St. Paul, Minn., $6,967, $52,969, $14,856; Watson Bros. & Hitchcock, Marinette, Wis., $5,698, $53,875, $20,139; John Sanderson, Marinette, $5,417, $48,273, $13,884; H. O. Foley & Co., Menominee, Mich., $5,907, $50,993, $19,423; Lovejoy & Youngreen, Minneapolis, $9,-380, $56,288, $22,856; Crilley & Wells, Milwaukee, sec. 2, $71,381. Contracts were awarded, as stated last week, to lowest bidders, the prices of Donald McLeod's bid being as follows: 44×66-in. brick sewer, 1,721 lin. ft., $6 per lin. ft.; 36×54-in., 1,770 lin. ft., at $5.50; 26×39-in. single ring, 1,147 lin. ft., at $2.75; 24-in. pipe sewer, 2,095 lin. ft., at $1.42; 20-in., 5,293 lin. ft., at $1.07 and $1.18; 18-in., 1,517 lin. ft., at 98 cts.; 15-in., 2,980 lin. ft., at 85 cts.; 12-in., 1,594 lin. ft., at 72 cts.; 10-in., 1,060 lin. ft., at 50 cts.; 8-in., 6,208 lin. ft., at 42 and 43 cts.; 52 manholes, at $35; 55 catch basins, at $22; flush tank, $60; 8-in. catch basin drain, 2,000 lin. ft., $800; pine lumber 23,000 ft., at $12 per M. ft., B. M.; piling, 1,500 lin. ft., at 30 cts. W. M. Campbell's bid was as follows: 20-in., 420 lin. ft., at $1.38; 18-in., 610 lin. ft., at $1.125; 15-in., 515 lin. ft., at 78 and 80 cts.; 12-in., 1,485 l'n. ft., at 53 and 83.5 cts.; 10-in., 350 lin. ft., at 56 cts.; 8-in., 1,510 lin. ft., at 44 cts.; 15 manholes, at $39; 10 catch basins, at $30; flush tank, $38; pine lumber, 8,500 ft., at $9 per M. ft. B. M.

St. Louis, Mo.—A. N. Milner, Engr. of Sewer Com., writes us that contracts have been recently awarded at the lowest prices ever received in the city considering the cost of material and work, which is as follows: Brick, $7 per M.; sand, $1.25 per cu. yd.; cement, 75 cts. per bbl.; 12-in. pipe, 18½ cts. per lin. ft.; 15-in., 25 cts.; 18-in., 45 cts.; labor, $2 for eight hours; brick-layers, 60 and 65 cts. per hour. The following contract was awarded to G. Eyerman & Co.: Excavation, 3,280 cu. yds., at 18 cts.; brick masonry, 1,380 cu. yds., at $5.90; 12-in. pipe, 10 ft., at 40 cts.; 15-in., 10 ft., at 50 cts.; 6-in. junctions, 20, at 50 cts.; 12-in., 12 at 75 cts.; 12-in., 5, at $1; inlet stone, 486 sq. ft., at 50 cts.; wrought iron, 250 lbs., at 5 cts. John Gilbane was awarded a contract at the following prices: Excavation, 460 cu. yds., at 25 cts.; brick masonry, 160 cu. yds., at $6.50; 12-in., pipe, average cut, 13 ft., 1,360 lin. ft., at 50 cts. per lin. ft. complete; 15-in., average cut 10 ft., 1,100 lin. ft., at 62 cts.; 18-in., average cut 10 ft., 870 lin. ft., at 80 cts.; 6-in. junctions, 185 ft., at 50 cts.; 12-in., 5 at $1; inlet stone, 486 sq. ft., at 50 cts.; cast iron, 10,002 lbs., at 2.5 cts.; wrought iron, 1,100 lbs., at 4 cts.

Erie, Pa.—A contract for 1,592 lin. ft. of 36-in. brick sewer, average cut 16.2 ft., has been awarded to V. D. Eichenlaub at $5.50 per lin. ft. The city furnishes brick, 8 × 6 × 2 × 2½ ins., costing 90.3 cts. per lin. ft., and cement, costing 40.25 cts. per lin. ft. The total cost, including well holes, manholes, 9-in. spill pipe, inspection, etc., will be $7.4173 per lin. ft. Geo. Platt, Cy. Engr.

DREDGING.—Wilmington, Del.—It is reported that the bids received for opening the Assawoman Canal, which is to form an inland waterway from Chincoteague Bay, Va., to Delaware Bay, Va., will be rejected as too high. They were as follows: Colin McLean, New York, 24 cts. per cu. yd. for section 1 and 25 cts. for section 2; R. G. Bailey, Philadelphia, 25 cts. for section 2; Isaac T. Brown, New York, 34¾ cts. for each; E. C. Smith, New York, 24.74 cts. per cu. yd. for section 2; F. C. Somers, Camden, N. J., 30 cts. for each.

Baltimore, Md.—The following contract has been awarded to the Baltimore Dredging Co.: Dredging 70,-000 cu. yds. of mud from the harbor and channels, at 12.5 cts. per cu. yd.; 60,000 cu. yds. from the Back Basin, at 15.5 cts.; 70,000 cu. yds. from the Spring Gardens, at 13.5 cts.; 40,000 cu. yds. from the mouth of harbor, 27 cts.; 60,000 cu. yds. from Jones' Falls, at 35 cts.

ASPHALT PAVING.—Baltimore, Md.—The only bids received for paving in two streets with Trinidad Lake asphalt were those of Isaac S. Pilbert, at $2.70 per sq. yd. The prices for 6-in. granite curbing ranged from 94.5 cts. to $1.10 per lin. ft.

ASPHALT, BRICK AND GRANITE PAVING.—Philadelphia, Pa.—Bids have been opened for about 20 miles of paving. The only bid considered for paving in Broad St. with asphalt, for which $300,000 has been appropriated, was that of the Vulcanite Paving Co., $2.95 or $3.15 for a 6 or 8-in. concrete base, respectively. The Philadelphia Construction Co. bid $3.20 for an 8-in. base, but failed to submit samples as required. The asphalt paving in this street last year cost $2.70 per sq. yd. For paving new streets with asphalt the Vulcanite Paving Co. bid from $2.60 to $2.75 per sq. yd. The Mack Paving Co. was the lowest bidder for paving with Belgian blocks and brick, at $3.50 to $4 per sq. yd. for blocks, and $2.25 for brick. All blocks or bricks are to be laid in 4 to 8 ins. of concrete.

GRANITE PAVING.—New Orleans, La.—Bids for paving with square blocks have been received as follows: C. J. Fayssoux, $5.50 per sq. yd.; Rosetta Gravel Paving & Impvt. Co., Georgia granite, $4; Rockport and Quincy granite, $5.75; Venable Bros., Georgia granite, $3.80; Rockfort granite, $5.09.

GRANITE BLOCKS.—Fall River, Mass.—Seven bids have been received for granite paving blocks, the prices ranging from $71 to $75 per M. blocks.

PIPE.—Cudahy, Wis.—The Cudahy Land & Investment Co. has purchased from Dennis Long & Co., Louisville, 340 tons of 12-in., and about 100 tons of 14-in. pipe, at $22.49 per ton, delivered in Cudahy.

HYDRANTS.—Minneapolis, Minn.—A contract has been awarded to R. D. Wood & Co., Philadelphia, Pa., for 80 hydrants, at $32 each.

SEWER BRICK.—Milwaukee, Wis.—The only bid for sewer brick was that of J. S. Burnham & Sons, at $10 per M., which the board of public works considers too high.

MISCELLANEOUS.

ARCH.—Cohoes, N. Y.—The city clerk will receive bids until June 6 for a brick arch in the Eagle's Nest ravine.

GAS PLANT IMPROVEMENTS.—Watertown, Wis.—It is reported that the Watertown Gas Co. will spend $20,000 in improving its plant.

CHANNEL.—Brookline, Mass.—Bids are asked until June 5 for a new channel, 1,500 ft. long, 10 ft. wide and 9 ft. high, for the village brook. A. H. French, Engr.

DAM.—Minneapolis, Minn.—It is reported that a dam will be built in the Mississippi River near this place, to cost nearly $1,000,000. Senator W. D. Washburn is a member of the syndicate.

DREDGING.—Philadelphia, Pa.—The contract for dredging in the harbor, the bids for which were received Jan. 31, has been awarded to the American Dredging Co., at $3,403,780. The bids were published in our issue of Feb. 9.

DRAINAGE.—Lafayette, Ind.—Bids are asked until June 17 for 7,055 ft. of tile and 945 ft. of open ditch in Lauramie township. Chas. F. Oneall, Comr. of drainage.

Macon, Ga.—The commissioners of Bibb county are considering the issue of bonds for $40,000 to drain the swamp below this city. Surveys for the work were recently made by Hazlehurst & Hendrick, Engrs., who recommended a canal 16,000 ft. long, average depth 8 ft., at a total estimated expense of $50,000.

DOCKS.—New York, N. Y.—The dock board has adopted plans for the construction of new piers and bulkheads estimated to cost $10,000,000.

Muskegon, Mich.—It is reported that Magroon & Kimball will construct a dock near the central wharf, to cost $10,000. It will have a traveling crane and other facilities for unloading cars and vessels.

Oyster Bay, N. Y.—The Oystermaen's Dock Co. has had plans prepared for a new dock and the construction will be commenced soon. Henry A. Townsend and Job Paynter are directors.

INDUSTRIAL NOTES.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., are building 1 ten-wheel passenger engine, 1 eight-wheel passenger engine and 2 six-wheel switching engines for the Louisville, New Albany & Chicago.

The Rhode Island Locomotive Works, Providence, R. I., have an order for 10 two-cylinder compound consolidation engines for the Minneapolis, St. Paul & Sault Ste. Marie; also for 16 two-cylinder compound and 5 simple engines for the Brooklyn Elevated.

The Pittsburg Locomotive Works, Pittsburg, Pa., are building 3 ten-wheel engines for the Pittsburg & Lake Erie, and have delivered 3 ten-wheel engines to the St. Louis, Vandalia & Terre Haute; one of the latter is at the World's Columbian Exposition.

The Brooks Locomotive Works, Dunkirk, N. Y., have built two passenger engines for the Cleveland, Lorain & Wheeling.

The Rome Locomotive & Machine Works have been incorporated at Rome, N. Y., to manufacture locomotives, portable and stationary engines, cars, machinery, etc. The capital stock is $150,000. The directors for the first year are: Thomas H. Stryker and Edward Comstock, of Rome; and William B. Isham, Henry A. V. Post and Ralph N. Ellis, of New York.

CARS.—The Ohio Falls Car Works, Jeffersonville, Ind., have built two vestibuled day cars, on six-wheel trucks, for the Louisville, New Albany & Chicago.

The Northwestern Car & Machine Co. has been incorporated at Detroit, Mich., with a capital stock of $500,000; Pres., R. P. de la Ronde; Secy. and Supt., F. A. Anderson.

THE BUFFALO BRIDGE & IRON WORKS, of Buffalo, N. Y., have bought the property of the defunct Railway Supply Co., on Bailey Ave. The property is 5¼ acres in extent, and the new buildings on it are 500 ft. long by 110 ft. wide. The property is situated on the Western New York & Pennsylvania R. R., the Delaware, Lackawanna & Western R. R., and the Lehigh Valley R. R. The company intends to go into the manufacture of railway bridges.

THE AMERICAN RAILWAY EQUIPMENT CO., Mr. O. S. Burr, Pres. and Gen. Man., has moved its offices from the Rookery to the Monadnock Block, Chicago. Mr. David Servis will have charge of the Chicago office.

NEW COMPANIES.—Stover Railway Rail-Joint Co., Fairfield, Ia.; $100,000; Pres., Geo. A. Willis, Long Island Construction Co., Jamaica, N. Y.; $50,000; Wm. G. Bosworth and Joseph H. Jones, of New York, and Wm. J. Kelly, of Brooklyn. The Albuquerque Safety Railway Switch & Rail Joint Co., Albuquerque, N. Mex.; $500,000; Geo. W. Hannes, Geo. W. Champion, and O. N. Marron.——M. Cavanagh Wrecking Co., Trenton, N. J.; $2,000,000; to raise sunken ships by bags inflated by means of hose; Joseph Grant, Tacoma, Wash.; J. Herbert Potts, Jersey City, N. J.